VOLUME 32 NUMBER 11 NOVEMBER, 1949

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OF
OPHTHALMOLOGY

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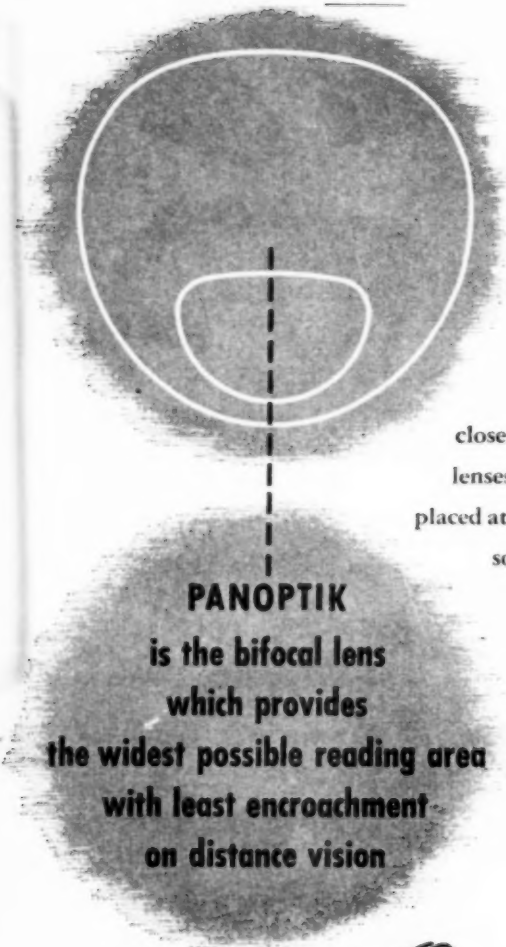

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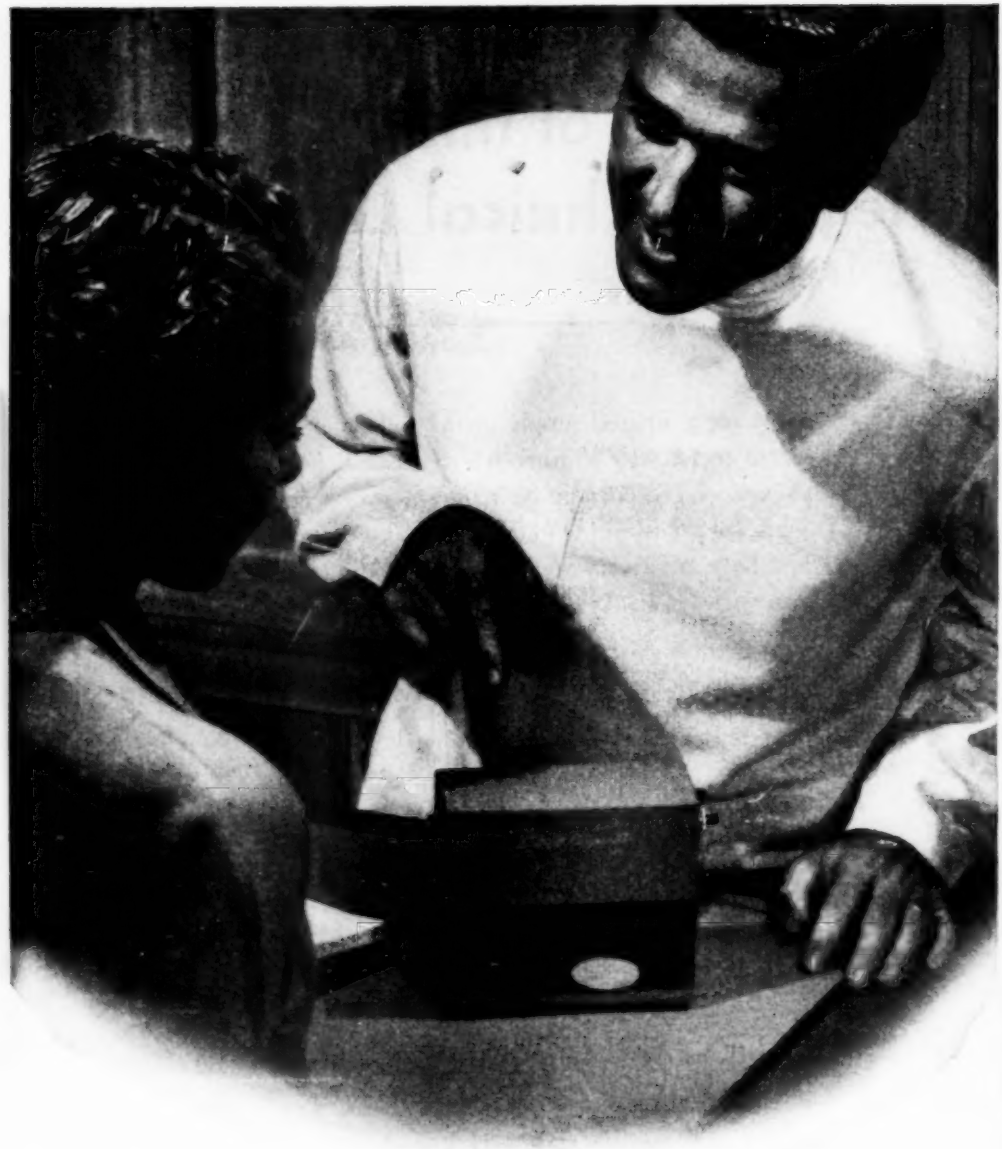

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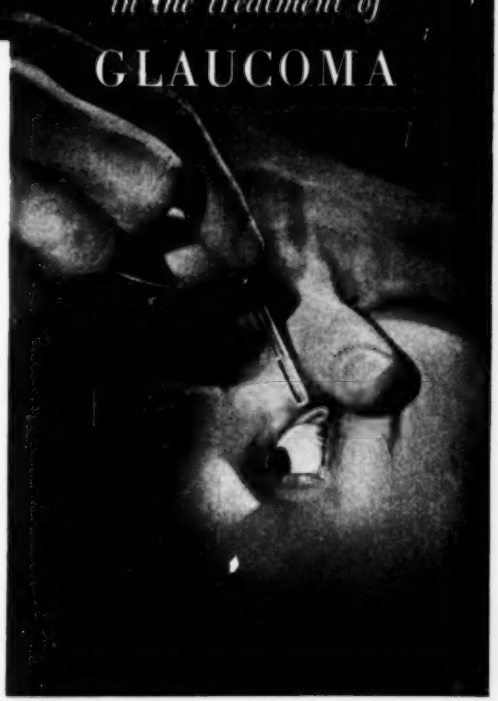

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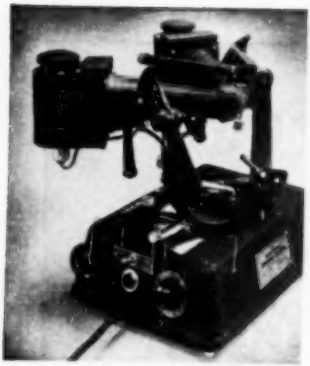

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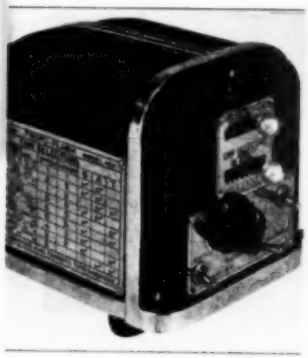

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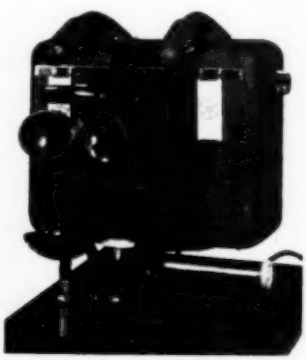

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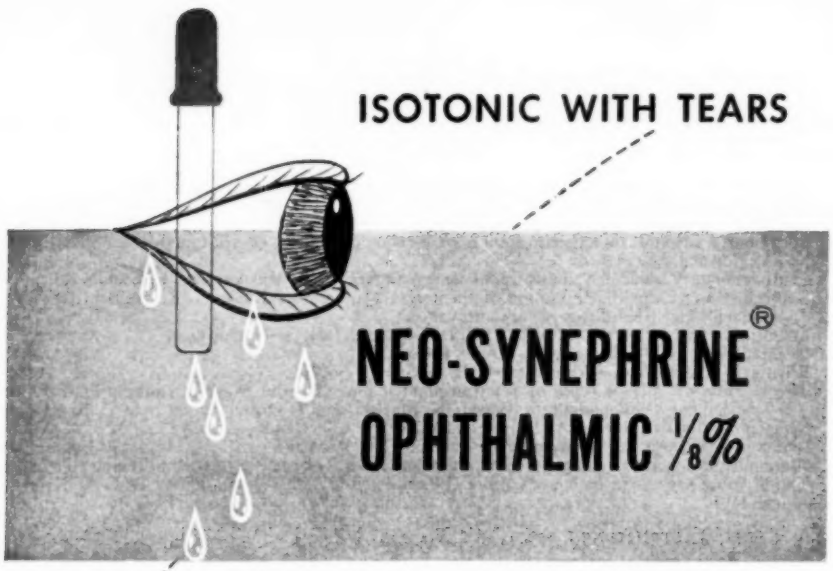

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AMERICAN JOURNAL OF OPHTHALMOLOGY

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THE DIAGNOSIS AND TREATMENT OF OCULAR ALLERGY*

ALAN C. WOODS, M.D.
Baltimore, Maryland

The proper diagnosis and treatment of ocular allergy require a clear concept by both the ophthalmologist and the allergist of the relation of hypersensitivity to inflammations of the external eye and uveal tract, of the specific allergens most frequently responsible for the hypersensitive state, and of the methods for detecting and treating such hypersensitivity. Much of our knowledge on these points is fragmentary and there are great gaps where little or nothing is known. In this paper, the effort is made to outline the broad principles of ocular allergy as we now understand them and to describe the methods of diagnosis and treatment usually accepted at the present time.

Allergic reactions in the eye are dependent upon an underlying hypersensitivity to a specific antigen and contact of this antigen with the sensitized cells. The underlying hypersensitivity may be either of the anaphylactic and pollen type or of the bacterial type.

The anaphylactic and pollen types of hypersensitivity are caused exclusively by proteins or by the combination of nonprotein substances (such as drugs or metals) with the native protein of the host, thus forming a new compound which acts as a foreign protein. In the anaphylactic and pollen types of hypersensitivity the reactions of the sensitized cells to contact with the specific antigen is an immediate one, is characterized by an urticarial weal, a contraction of smooth muscle, and increased capillary permeability. It is believed due to the liberation of histamine or a histaminelike substance. The anaphylactic reaction does not in itself cause actual damage to the cells. However, after repeated local anaphylactic reactions an Arthus phenomenon may occur. This is the occurrence of local necrosis and is due not to a direct toxic action on the cells, but to thrombosis and rupture of the nutrient vessels.

The hypersensitivity of infection is also known as bacterial hypersensitivity or the tuberculin type of hypersensitivity. It is produced only by the parenteral contact of the tissue with the living or dead bacterial body or filterable viruses. It cannot be produced by the soluble proteins of the organisms, but once the hypersensitivity is produced by the bacterial body, reactions can be elicited by the soluble specific proteins. When tissues with the bacterial type of hypersensitivity come into contact with the specific bacterial antigen or its soluble products, the allergic reaction is delayed, coming on in 24 to 48 hours. The reaction in bacterial allergy causes actual damage to the cells, in severe cases actual death and necrosis. The cause of this cell damage is not clear—it is variously believed that the antigen-antibody union produces a toxin which damages the cells, or that the cell damage is the result of some enzymelike action.

CLINICAL ALLERGIC REACTIONS

The various clinical allergic reactions in the eye may be classified as follows.

* From the Wilmer Ophthalmological Institute of The Johns Hopkins Hospital and University.

A. Conjunctiva

Four types of allergic reactions are recognized in the lids and conjunctiva:

1. *A sudden, edematous type of reaction*, affecting primarily the conjunctiva alone, characterized by a glassy edema of the conjunctival fold, marked congestion of the palpebral and bulbar conjunctiva with profuse lacrimation, sudden in its onset, and sudden in its disappearance.

The classic example of this type is the conjunctivitis associated with hay fever and asthma. This is a typical pollen-type hypersensitivity. The mucous membrane of the eye participates in the general hypersensitivity of the mucous membranes of the upper respiratory tract and like them reacts with a sudden inflammatory edema when in contact with the specific sensitizing substance, the air-suspended allergens. There is usually chemosis of the palpebral and bulbar conjunctiva, profuse lacrimation, and a nonpurulent secretion without bacteria. The reaction usually subsides quickly after the instillation of epinephrine hydrochloride.

2. *Eczematous, edematous type of blepharoconjunctivitis.* The lids are swollen with a firm edema, the margins are inflamed, the skin of the lids has a characteristic, dry, eczematous feeling, the palpebral conjunctiva is congested; there is usually a slight chemosis. There is profuse lacrimation. The most frequently observed example of this type of allergic reaction is that due to drug sensitivity, atropine, butyn, and other alkaloids. As already stated, the drug, *per se*, is not believed to be the offending allergen, but a combination of the drug with the native protein, forming a new specific allergen which is foreign to the host.

3. *Chronic or recurrent irritative conjunctivitis.* Often this is associated with a slight marginal blepharitis. Subjectively, the most pronounced symptoms are a sensation of dryness and itching. Objectively, there is usually a slight or moderate congestion of the palpebral conjunctiva, often with small patches of dry folliculosis and no chemosis. A low-grade irritative marginal blepharitis, usually without crusts of any cutaneous reaction, may be present. The allergens responsible for the underlying sensitivity may be bacterial, notably staphylococcus toxin, or the various epidermals, inhalants, animal dusts, and so forth.

4. *Vernal catarrh.* The clinical picture is almost characteristic, with seasonal occurrence, lacrimation, itching, conjunctival congestion, with large follicles over the palpebral, and occasionally on the bulbar conjunctiva. In the latter stages, these assume the appearance of large "cobblestone" follicles with irregular distribution.

The evidence in favor of an underlying allergy as the predisposing cause is the seasonal occurrences of the attacks, the tendency of the disease to attack the young, the comparative absence of bacteria in the secretions, the usual abundance of eosinophiles in the discharge, the specific hypersensitivity to various allergens so often demonstrated, and the general allergic diathesis of many of the patients.

B. Cornea

Two types of superficial keratitis are believed to be allergic in origin—phlyctenular keratoconjunctivitis and recurrent marginal ulcers. It is quite possible that various other forms of superficial keratitis may be on an allergic basis, or their course influenced by a concomitant hypersensitivity of the corneal epithelium to bacteria or filterable viruses.* However, as a rule, such relationship is so tenuous or hypothetical that from the practical standpoint it is of little concern.

It is also undeniably true that the course of certain forms of deep keratitis (notably tuberculous keratitis and the nummular keratitis sometimes seen in chronic brucellosis) is profoundly influenced by the degree of specific local sensitivity present in the

* Such as recurrent corneal erosion after minor corneal trauma and infection.

cornea. The problem here, however, is identical to that of similar endogenous infections of the uveal tract and the same principles which influence them would govern corneal lesions. These will be discussed later.

1. Phlyctenules. The well-known clinical picture requires little comment. The onset is usually acute, small millet-seed nodules forming on the cornea and occasionally on the adjacent conjunctiva, usually at or near the limbus, the phlyctenules being surrounded by a zone of local inflammation. A grayish crater soon forms at the apex, absorption is rapid, and the small ulcer so formed epithelizes over rapidly, usually leaving little trace. They frequently occur in small showers, and recurrences are common.

The allergic basis of phlyctenules appears clearly established. Phlyctenules in both man and experimental animals have been produced by the instillation of tuberculin in the conjunctival sac, and by the instillation of other specific sensitizing allergens. Tuberculoprotein is the allergen commonly incriminated, and, in children suffering with phlyctenulosis, a high degree of tuberculin hypersensitivity can usually be demonstrated, and likewise a history of exposure to open tuberculosis. Various other allergens have from time to time been incriminated. The diagnosis offers no difficulty.

2. Marginal ulcers. These begin as small infiltrates, near the limbus, they rapidly break down and form small pinhead ulcers, often in a crescent around the limbus. There is associated hyperemia. The tendency is to rapid healing without deep penetration. Itching and irritation are marked. Recurrences are common. They occur frequently in elderly people and may follow a catarrhal conjunctivitis. Low-grade foci of infection, in the sinuses, tonsils, and so forth, are frequently found.

The evidence that these ulcers are allergic is largely circumstantial and not altogether conclusive. Cultures of the ulcers are usually sterile. The patients usually show evidence of bacterial hypersensitivity and the presence of remote foci of infection. A concomitant or preceding low-grade conjunctivitis is the rule oftener than not. The fact that they occur characteristically near the limbus has given rise to the supposition that the intoxicating bacterial allergens may reach the sensitized corneal epithelium at the limbus from the adjacent vascular bed. The patients usually do well on specific desensitization and recurrences can, as a rule, be controlled. On these grounds, and the inability to find any other concrete cause to explain them, this type of marginal ulcer is usually regarded as an example of bacterial allergy.

C. Uveal tract

Allergic reactions of the uveal tract may be classified as follows: (1) Inflammations related to a hypersensitivity from absorption of the native organ specific proteins of the eye, uveal pigment and lens protein (sympathetic ophthalmia and endophthalmitis phacoanaphylactica); (2) nongranulomatous uveitis due *per se* to a bacterial hypersensitivity; (3) granulomatous uveitis due to the direct invasion of the ocular tissues by specific living pathogens, in which the course and character of the lesion is influenced by tissue hypersensitivity.

1. a. Sympathetic ophthalmia. The assumption of an allergic phase in sympathetic ophthalmia is based upon an abnormal reaction to uveal pigment, developed by the body cells either before the outbreak of the disease or early in its course.

The pigment of the uveal tract possesses the immunologic quality of organ specificity and lacks species specificity—in short, it is potentially able to act as a foreign protein in the homologous animal.

The abnormal reaction to uveal pigment may be demonstrated by injecting small amounts of uveal pigment in the skin. The results are epithelioid, and lymphocytic infiltration about the injected pigment and phagocytosis of the pigment occur—a picture comparable to the histologic picture of

sympathetic ophthalmia in the eye.

This hypersensitive reaction to pigment does not, however, appear to be the cause *per se* of the disease for it may be present in some individuals with posttraumatic and postoperative uveitis without sympathetic disease. It apparently sets the stage for the outbreak of the disease and determines its pathologic and histologic pattern.

Other, as yet unknown, and possibly quite nonspecific factors, may be responsible for the actual causation or outbreak of the disease, once the stage is set by the development of pigment hypersensitivity. The development of cutaneous hypersensitivity to uveal pigment after any traumatism or operative insult to the uveal tract of the eye is therefore a cause for alarm and increased vigilance.

1. b. Endophthalmitis phaco-anaphylactica. This is a term applied to an endogenous inflammation of the uveal tract, supposed to be dependent on the development of a hypersensitivity to lens protein, and the further absorption of lens protein by the sensitized tissues. It has been abundantly demonstrated that some of the proteins of the lens are organ specific and lack species specificity and are thus potentially capable of acting as foreign proteins. It is also recognized that an inflammatory reaction may follow the absorption of lens protein.

There has, however, been considerable question of the allergic or anaphylactic nature of this recognized clinical disorder, many observers pointing out the weak antigenic action of lens protein and attributing the delayed inflammation which follows its absorption to an inherent toxicity of the material, to a low-grade infection, or to both.

The weight of evidence, however, indicates there is an actual hypersensitivity to lens protein in individuals with this type of ocular reaction. The development of the hypersensititive state may be related to the synergistic actions of toxins absorbed from some remote focus of infection or an actual low-grade infection in the eye, such a factor enhancing the antigenic activity of the lens protein and producing the hypersensitive state. Further evidence that this is a clinical entity are the therapeutic results which follow proper desensitization procedures.

2. Nongranulomatous uveitis. The nongranulomatous uveitis resulting from a bacterial hypersensitivity is dependent upon a prior infection with the specific bacteria. The original infection may have been in the eye, in which case the ocular tissues are especially reactive; or it may have been a systemic infection, the eye participating in the general tissue reaction. Once this hypersensitive state has been established, an allergic inflammatory reaction may be elicited either by contact of the sensitized cells with the soluble bacterial protein, as in the case of ocular focal reactions produced by tuberculin, or by direct contact with the living or dead bacterial body, as in the case of the experimental "ophthalmic reaction."

Nongranulomatous uveitis in the anterior uvea is characterized by an acute onset, with marked ciliary congestion, photophobia, and lacrimation. The inflammatory changes in the iris are usually limited to loss of luster, blurring of the normal iris pattern, and dilatation of the capillaries. There is frequently a gelatinous or fibrinous exudate in the anterior chamber. The keratitic precipitates are usually small, pinpoint in type, and composed chiefly of lymphocytes. The course is stormy but usually brief, and the eyes recover with amazingly few residua. After repeated attacks, however, organic changes may take place in the eye, with synechia and organized exudates, and the eyes assume the picture of the granulomatous form of the disease. The destructive changes which occur after repeated attacks of nongranulomatous uveitis may possibly be interpreted as an Arthus phenomenon.

In the posterior uvea, the nongranulomatous uveitis is not so characteristic. In general, the eyes show only slight blurring of the vitreous; there are no discernible exu-

dates, but there is marked subretinal edema, blurring the elements of the fundus pattern.

Nongranulomatous uveitis is seen, in its purest form, in the iritis and uveitis associated with rheumatoid arthritis or with old gonococcal infections. The supposition is that, at the time of a former bacteriemia, the eye has been invaded by the organisms. These bacteria have been destroyed by the normal bactericidal action of the ocular fluids but, as a result of the ocular invasion and parenteral contact of the tissues of the eye with the organism, there has been left behind a hypersensitivity of the uveal tract. Any later contact of this sensitized ocular tissue with the specific organism or its products, brought to the eye either by a later chance transient bacteriemia or by absorption of the bacterial products from a focus of infection, or, indeed, from a normal cutaneous or mucous membrane surface, results in a sudden, sharp, allergic reaction. The underlying sensitivity is probably of the bacterial type, although there may be an anaphylactic type of sensitivity to the hapten or polysaccharide fraction of the invading organisms.

3. Granulomatous uveitis. The underlying cause of granulomatous uveitis is an actual invasion of the uveal tract by the causative organisms in their living form. Granulomatous uveitis may be caused by tuberculosis, syphilis, brucellosis, sarcoidosis, toxoplasmosis, virus diseases, and quite probably by other as yet unidentified agents.

The clinical picture of granulomatous uveitis is quite different from that of nongranulomatous uveitis. The onset is usually insidious; the inflammatory reaction is not unduly severe. Organic changes occur in the iris with edema of the iris stroma, often localized thickening or felting of the iris, and frequently with actual nodules or tubercles. There is a marked tendency to the formation of posterior synechias and greasy exudates over the anterior capsule of the lens. The keratic precipitates are usually heavy, of the mutton-fat variety, and are composed chiefly of epithelioid cells. Small accumulations of epithelioid cells may occur on the pupillary border or over the surface of the iris, the so-called Koeppe and Busacca nodules. In granulomatous disease of the posterio uvea, the characteristic picture is heavy vitreous opacities and actual exudates, with more or less associated subretinal edema.

The influence of a hypersensitivity in granulomatous uveitis is best illustrated by the tuberculous form of the disease, where the question has been extensively studied. While the injection of tuberculin and other fractions of the tubercle bacilli will produce pure allergic reactions in sensitized tissue, the progressive tuberculous lesions with cellular infiltration, tubercule formation, tissue necrosis, and caseation or encapsulation are produced only by the actual invasion of the tissues by the tubercle bacillus.

The acute inflammatory phases of the lesion with tissue destruction, caseation, and necrosis are dependent largely upon tissue hypersensitivity to tuberculoprotein. If there is no restraining immunity, the tubercle bacilli spread rapidly and first produce hard tubercles. Thereafter, tissue hypersensitivity to tuberculoprotein develops, and with this there is acute inflammation, and lastly, necrosis, and caseation. If the spread and multiplication of the bacilli is restrained by the forces of immunity, the development of tissue hypersensitivity is slight.

The character of a tuberculous lesion is therefore largely dependent upon the balance of immunity and tissue hypersensitivity present. The other factor is, of course, the number and virulence of the invading bacilli. With this last factor a constant, circumscribed, rapidly encapsulated lesion should be regarded as an indication of high immunity and low tissue hypersensitivity; while spreading, destructive lesions are dependent upon a low immunity and high tissue hypersensitivity. Lesions midway between these two extremes are dependent upon the varying balance of these two factors.

The therapeutic indications based on this

concept of the pathogenesis of tuberculous lesions are obvious. The invading bacilli may be attacked by the chemotherapeutic and antibiotic agents which have a specific action on the tubercle bacillus. All possible efforts should be made to achieve any possible enhancement of immunity and the fatal tissue hypersensitivity should be abolished. This latter can be done only be desensitization with tuberculin.

It is quite probable that allergy may play an equal role in other forms of granulomatous uveitis, although this is as yet unproved.

Diagnosis of ocular allergy

The diagnosis of an allergic ocular disorder depends upon two basic points, the recognition of the probability of a hypersensitive state being concerned in the clinical picture and the proof of an underlying specific hypersensitivity.

The recognition of the probable existence of hypersensitive reactions begins with the history, which often suggests an underlying allergy, the realization that the clinical picture is similar or compatible with an allergic reaction, and the elimination of other manifest causes for the ocular disease—bacterial infection, metabolic disorders, degenerations, and so forth.

The proof of a specific hypersensitivity depends upon the demonstration of an increased cutaneous or ocular reactivity to nonbacterial or bacterial allergens.

The cutaneous reactivity is demonstrated by either the patch or the intracutaneous test. The latter is preferable in as much as it permits exact dosage, and an accurate determination of the degree of reactivity. The intracutaneous test consists in the injection of 0.05 cc. or 0.1 cc. of the various allergens, in varying concentration, in the superficial layers of the skin, raising a small bleb slightly less than the size of a dime. The tests are read at the end of 15 minutes for an immediate anaphylactic reaction, and at the end of 48 hours for the delayed tuberculin-type of reaction.

Increased ocular reactivity is determined by the ophthalmic test. This is, however, neither as simple, conclusive, nor as safe as it first appears, for the local reaction following the direct instillation of a specific allergen in the conjunctival sac may be of such severity that the eye may be permanently damaged. It is therefore doubtful if this diagnostic procedure is justified except in rare instances.

The technique of the ophthalmic test is as follows. An extremely dilute mixture of the allergen is first used (a 1:100 dilution of the dose causing a cutaneous reaction.) One drop is instilled in the conjunctival sac. The patient is instructed to keep his eyes gently closed to facilitate absorption. With the airborne allergens, where the hypersensitivity is of the anaphylactic or pollen type, the reaction is an immediate one, comes on within 15 minutes, and is usually limited to conjunctival erythema.

If the instillation of the weak dilution gives no reaction, the test may be repeated at the end of one-half hour, using a 10 times stronger dilution. Stronger dilutions than a 1:10 dilution of the strength producing a skin reaction should not be used.

If a positive reaction is obtained, manifested by conjunctival congestion, lacrimation, secretion, and so forth, the eye should be immediately and thoroughly washed out with saline and epinephrine hydrochloride should be instilled. With the bacterial allergens where the hypersensitivity is the delayed tuberculin type, any reaction is delayed and comes on only after 24 to 48 hours.

A positive reaction to bacterial antigens may be characterized not only by the erythema and edema, but even by phlyctenules and marginal corneal ulcers. If the test is negative, one is never sure that a sufficient concentration of the bacterial antigen was used, or if absorption took place. Thus negative tests are inconclusive, and positive tests may be disastrous. It is therefore more than

questionable if the direct introduction of bacterial antigens in a suspected hypersensitive conjunctival sac is ever warranted.

When one considers the vast number of protein compounds, air-borne allergens, drug compounds, and bacterial fractions to which an organism may become hypersensitive, the complexity of the diagnostic problem is at once evident. There are, however, certain broad clinical principles on ocular hypersensitivity which may be emphasized.

Primarily there is no evidence that food allergy plays any role in the production of any form of ocular allergy. Patients may be found hypersensitive to wheat, in whom the instillation of the most minute amount of wheat or flour in the conjunctival sac causes the most violent reaction. Such patients do not, however, as a rule develop ocular symptoms after the ingestion of bread, pastry, flour, and so forth. It is reasonably clear that actual contact of the sensitized conjunctiva with the specific allergen is necessary to cause an ocular reaction. This limits the field to the air-borne allergens, the organ-specific tissue extracts, and the bacterial antigens.

I. Air-borne allergens

The most important air-borne allergens usually incriminated in allergic conjunctivitis are the spores, pollens, inhalants, including house dust and animal dander. In the routine testing of any patient, the tests may be extended to include usual groups of common foods. In actual practice, the various allergens are divided into groups, each containing from 5 to 24 component members. There are some 14 of these groups.

All these various allergens used for testing are standardized on their protein-nitrogen-base content and are diluted to the proper concentration for testing. The spores (Group I) are used in three concentrations: 1:1,000, 1:100, and 1:10. The rare tree pollens (Group II—ash, poplar, and so forth) and the rare grass pollens, (Group III—Bermuda grass, and so forth) are used 1:1,000, 1:100, and 1:10. The epidermals and inhalants (Group IV), of which there are 18 components (black flag, camel hair, cat hair, feathers, cow epidermal, dog hair, stock dust, goat epidermal, horse dander, kapok, orris root, rabbit hair, sheep wool, cotton seed [1:1,000], flaxseed [1:1,000], silk, rayon, tobacco), are used in concentrations 1:100 and 1:10. Groups 5 to 11 and 15 are all foods, vegetables, fruits, grains, dairy products, meats, fish, and common foods. These are all used 1:10 in intracutaneous testing. The nuts (Group 11) are used 1:100 and 1:10. All these allergens, spores, pollens, epidermals, and inhalants, various foods and nuts, are read for the immediate anaphylactic or pollen type of reaction.

II. Organ specific tissue extracts

A. Uveal pigment. Uveal pigment is not available commercially. It is prepared as follows from fresh beef eyes obtained at a slaughter house. The eyes are scalded and clipped free of adventitious tissue. Under aseptic precautions the cornea is clipped away, the eye opened by a sagittal section, the lens expressed, the retina removed, and the uveal tract dissected out *in toto*.

The uveal tracts of several eyes are then ground in a sterile mortar with salt solution and broken glass until all the pigment has been ground from the tissue. This pigment-containing water is then decanted, precipitated with 50-percent ammonium sulphate, the pigment thrown down and removed by centrifugation. This is then washed six times in sterile distilled water and finally taken up in normal salt solution, 5.0 cc. of salt solution to each uvea. This gives a 0.5-percent pigment concentration. Tricresol (0.5 percent) is then added as a preservative.

The cutaneous sensitivity is determined by injecting 0.1 cc. of the pigment suspension intracutaneously. The site of injection is then read for erythema and induration at the end of 30 minutes and 1, 2, 24, and 48 hours. In a positive reaction there is often a visible

macroscopic cutaneous reaction at the end of one hour and 24 hours. The pigment is so slowly absorbed that this dermal reaction may be inconspicuous.

The diagnosis of a positive reaction is usually made by histologic study of the excised skin. At the end of two weeks the bit of skin containing the pigment is excised and sectioned for microscopic study. The microscopic appearance of a positive reaction is striking. The tissue is densely infiltrated with lymphocytes, epithelioid cells, and giant cells, and practically all the pigment is phagocytosed by the epithelioid and giant cells. In a negative reaction, the pigment is inertly distributed throughout the dermis, without cellular reaction or cellular invasion of the tissue.

B. Lens protein. Lens protein for testing and treatment is not available commercially. It is prepared as follows. Beef eyes are obtained from the slaughter house. Under aseptic conditions the lenses are extracted. The lenses are immediately taken up in one-hundredth normal NH_4OH, with 0.5-percent tricresol added, 20 cc. to each lens. These are then shaken 24 hours with broken glass, the gross particles removed by centrifugation and passed through a coarse (B) Berkefeld filter. A specimen of the filtrate is then dehydrated at 104° C. and the total solids are determined. The balance of the filtrate is then adjusted to 2-percent concentration of lens protein and 0.85-percent NaCl by adding distilled water and 10-percent NaCl solution.

The cutaneous sensitivity is determined by the injection of 0.1 cc. of the 2-percent solution intracutaneously. The test is read at 1 hour, at 24, and at 48 hours. Theoretically, the reaction should be an immediate one, but lens protein is such a weak antigen that the reaction is usually of the delayed type. As a control, 0.1 cc. of 0.5-percent tricresol in salt solution is used.

III. Bacterial antigens

When the infinite number of bacteria to which mankind is continually exposed is considered, and the number of antigenically distinct strains which exist for many organisms, it is manifestly impossible to examine for hypersensitivity to all bacteria, or completely to exclude bacterial hypersensitivity in any given case. All that is practical is to examine for hypersensitivity to what appear to be the most important organisms, and when hypersensitivity is found, to determine, when indicated, the specific strain responsible for the sensitivity.

In inflammations of the external eye, where the hypersensitivity is certainly the result of contact with air-borne bacteria, the most important organisms are the staphylococcus, and to a less degree the streptococcus. In uveitis, the hypersensitivity is the result of contact of the uveal tract with organism in the blood stream. In the nongranulomatous disease, the most important organisms are the streptococcus, and to a less extent the gonococcus. In the granulomatous form the most important organisms are the Mycobacterium tuberculosis and Brucella. With these various organisms there are certain basic immunologic and bacterial concepts which should be remembered.

A. Staphylococci. The diagnosis of hypersensitivity to staphylococci or their products is determined by use of the staphylococcus toxin or toxoid. Staphylococcus toxin is prepared by growing a toxin-producing strain of staphyloccus in hormone bouillon for 10 days at 37°C. Tricresol (0.5 percent) is then added, the culture is centrifuged, and the supernatant fluid is filtered through a Berkefeld V filter. The toxoid is prepared by growing the staphylococci on semisolid agar under partial carbon-dioxide tension, and the filtrate is detoxified with formaldehyde.

The toxin and toxoid further differ in that the toxin contains no rabbit erythrocyte hemolysin or dermonecrotizing factor and is not lethal for young rabbits but is highly toxic for older rabbits. The toxoid contains these factors and is moderately toxic for rabbits of any age. Both filtrates produce, in horses, serums which are equally effective

in neutralizing the lethal effects of toxin in rabbits. The toxin is not usually available commercially, while the toxoid is so available. Both have equal therapeutic effects in man.

The cutaneous hypersensitivity is determined by the injection of 0.1 cc. of a 1:100 dilution of the toxin intracutaneously, and by the later injection of a similar amount of a 1:1,000 or 1:10 dilution, depending on whether the first injection gave a positive or a negative result. The reaction is of the delayed tuberculin type, coming on from 24 to 48 hours after the test injection. A reaction of 3 by 3 cm. to the 1:100 dilution is regarded as the usual reaction in a normal individual. Reactions greater than this, or similar reactions to a 1:1,000 dilution are regarded as indicative of hypersensitivity.

Individuals with this hypersensitivity appear peculiarly susceptible to contact with toxin-producing staphylococcus, the mechanism of local infection appearing to be an antigen-antibody reaction. Such hypersensitive individuals may be protected by repeated injections of the staphylococcus toxin (or toxoid), the injections being repeated with stronger dilutions until the individual is nonreactive. Whether this is a desensitization process or an active immunization is not clear—it is probably the former. The toxin prepared from any strong toxin-producing organism gives this protective reaction not only against toxin-producing strains, but also against the nontoxin-producing albus strains and against the pus-producing strains.

B. Streptococci. The situation as concerns the streptococci is far more complex and there is no individual strain or universal toxin which permits a quick and easy manner of determining streptococcus sensitivity. The streptococci are generally divided into the alpha, beta, and gamma types on the basis of their hemolysis. The alpha streptococci produce a greenish discoloration and partial hemolysis on blood agar plates. This group includes the Str. pyogenes, Str. viridans, some four or more other strains of a relative low-grade pathogenicity for man. The beta produces clear hemolysis on blood agar plates and contains most of the human pathogens. The gamma group gives no hemolysis, and the streptococci of this group are rarely pathogenic for man.

The beta group is subdivided into various subgroups, A, B, C, D, E, F, G, H, and K, on the basis of different antigenic action. Each subgroup has a common polysaccharide, but the individual strains differ in their bacterial body proteins.

The "A" group is by far the most important and contains most of the streptococci pathogenic for man. The various strains in this group differ in acid-soluble proteins known as the "M" and "T" substances. The nature of this "M" and "T" substance determines the individual antigenic action. In the "A" group of the beta streptococci are now 42 known pathogens for man, all antigenically distinct.

The B, D, E, H, and K groups are only rarely pathogenic for man. The "F" group is the minute beta staphylococcus. There are a few pathogens in the "C" group, probably closely related antigenically. There also appear to be a few low-grade pathogens for man in the "G" group, probably related antigenically.

Thus the complexity of demonstrating a specific hypersensitivity to streptococci is apparent. Such a sensitivity must finally be determined by intracutaneous tests with the individual strains. In actual practice the following are the minimum number of test vaccines which should be used: Alpha streptococci, one strain; Beta streptococci—subgroup A, all 42 strains; subgroup C, one strain; subgroup F, one strain; subgroup G, one strain; Gamma streptococci, one strain. If desired, the study may be further extended by the use of additional strains of the Alpha, representatives of the subgroups B, D, E, H, and K of the Betas and by additional pathogens from the Gamma group.

The test vaccines are prepared as follows: Organisms of each strain are grown for 24 hours on trypticase soy broth, are killed,

washed to remove traces of the broth or any exotoxin, taken up in salt solution, a preservative added, and the density of the vaccine standardized to the desired concentration on a spectrophotometer.

In actual practice it has been found that the optimum concentration of a test vaccine for individual strains is a 1:10 dilution of T-50, or approximately T-5. In higher concentrations the protein content is so great that nonspecific reactions may be elicited. The patient is tested intracutaneously with 0.1 cc. of each of the 42 strains of the "A" group and one representative of the B, C, D, F, and G groups. The tests are read at the end of 48 hours.

As a short cut to determine sensitivity to the 42 individual "A" strains, four master mixtures are sometimes used. These master mixtures each contain 10 or 11 individual strains. The concentration is adjusted to a 1:10 dilution of T-50 and the patient tested intracutaneously with each master mixture. The mixture to which the patient gives the strongest reactions is noted, and the patient is then tested out similarly to each of the component members of this master mixture.

The weakness of using such master strains is that the combination of individual strains lowers the concentration of each strain to such a point it may be too low to elicit reactions. If the individual strains are used in higher concentrations to compensate for this dilution, the resulting protein content of the master mixture may be so high that nonspecific reactions result.

In the interpretation of results, it should be remembered that, since exposure and infection with streptococci is more or less frequent in all patients, undue consideration should not be given to weak reactions, and a test vaccine should not be used in too great concentrations.

C. Gonococcus vaccine

The antigenic structure of the gonococci is largely unknown. There are probably two main types with different but probably related antigenic properties. These two strains are supposed to occur respectively in acute infections (Type I) and in chronic infections (Type II). Between these two extremes may be a number of intermediates, containing antigenic fractions common to both main types. Further, there is some evidence that the nucleoproteins of the gonococcus resemble those of other Gram-negative cocci, and the polysaccharide fraction is related to the polysaccharide fraction of Type III pneumococci. Thus the complexity of the problem is evident, and the difficulty of establishing a specific hypersensitivity is likewise apparent.

In routine testing with vaccines prepared from gonococci, if Type I and Type II are available, the patient may be tested with each strain. Probably equally significant results are obtained by the use of any single strain. For diagnostic use the vaccines should be prepared in the concentration which gives the most specific readings. This concentration is usually about T-50. The vaccine is preserved with 0.5 tricresol. The test injections are made in the forearm, 0.1 cc. of vaccine being injected intracutaneously with a proper saline control containing 0.5-percent tricresol. The tests are read in 15 minutes for the immediate anaphylactic type reaction to the polysaccharide or hapten group and at the end of 24 and 48 hours for the delayed tuberculin type reaction to the bacterial body protein.

D. Organisms from a focus of infection

The probable relationship of remote foci of infection to endogenous ocular disease has long been recognized. The mechanism through which a focus of infection produces inflammatory changes in a remote tissue or organ has been a subject of considerable controversy. It is now generally assumed that the probable mechanism is through bacterial hypersensitivity, the remote tissue or organ becoming sensitized to the organisms from the focus of infection, and intoxication resulting from absorption of the soluble bacterial products from the focus.

The only means of demonstrating such a

hypersensitivity is by determining the bacterial flora of the infected focus, selecting such organisms as appear suspicious, and testing the patient's cutaneous sensitivity to these organisms.

Test vaccines should thus be prepared from suspicious organisms cultivated from a focus of infection. Organisms other than streptococci are probably best used in a T-50 concentration, and the streptococci in a 1:10 dilution of the T-50. The test dose is 0.1 cc. intracutaneously with proper controls. Lacking definite information of the antigenic action of such organisms, the tests should be read at the end of 15 minutes for an immediate reaction, and at the end of 48 hours for the delayed reaction.

E. Other organisms

The other common pathogens appear relatively unimportant in the production of a bacterial hypersensitivity of the eye, although their possible role in the production of allergic ocular reactions has not been adequately explored. A specific sensitivity for pneumococci is difficult to determine, since the specificity is determined by the polysaccharide fraction, and to date at least 70 or more antigenically distinct strains have been isolated. The delayed reaction to the protein fraction of the pneumococcus is not type specific.

There has been some circumstantial evidence produced incriminating the coliform bacilli in uveitis. It has been shown that the colon bacteria produce in culture media a toxic substance which has an irritative action on the uveal tract. There is, however, no evidence yet adduced of a hypersensitive state to the coliform organism in patients with uveitis, or the importance of such a hypothetical hypersensitivity.

There is little or no evidence that other bacteria or bacterial products, H. influenzae, and so forth, are concerned with endogenous ocular disease, although it is highly probable that many other heretofore unsuspected strains of bacteria, as well as filterable viruses, may ultimately be incriminated in both nongranulomatous and granulomatous uveitis.

F. Tuberculin

Cutaneous hypersensitivity to tuberculin may be determined either by old tuberculin or by the Purified Protein Derivative (P.P.D.). The technique of the intracutaneous test (Mantoux) is as follows:

a. Old tuberculin. Three intracutaneous injections of O.T., with one saline control, are made.

Right forearm	(upper) Control—0.1 cc. normal saline with preservative
	(lower) 0.001 mg. O.T. (0.1 cc. O.T.—1:100,000 dilution)
Left forearm	(upper) 0.01 mg. O.T. (0.1 cc. O.T. —1:10,000 dilution)
	(lower) 0.1 mg. O.T. (0.1 cc. O.T. —1:1,000 dilution)

If there is no reaction to 0.1 mg. after 48 hours, 0.1 cc. of O.T. (1:100 dilution) is given. This represents an intracutaneous dose of 1.0 mg. If there is no reaction, the patient is considered insensitive to tuberculin. If the patient shows a strong reaction to the test dose of 0.001 mg., the test is repeated with 0.0001 mg. (0.1 cc. of dilution—1:1,000,000) to determine the limit of extreme hypersensitivity.

b. Purified Protein Derivative. The P.P.D. comes in two vials. Vial No. 1 contains 0.0002 mg. P.P.D. to the cc.; vial No. 2 contains 0.05 mg. P.P.D. to the cc. The intracutaneous dose is 0.1 cc. of these two strengths, the equivalent of 0.004 mg. O.T. and 1.0 mg. O.T. respectively. If the patient reacts to strength No. 1, he is considered highly sensitive, if only to test No. 2, as slightly sensitive, if negative to vial No 2, as insensitive.

In the interpretation of the cutaneous reactivity to tuberculin the following fact must be borne in mind. If the cutaneous sensitivity is high, the ocular sensitivity must likewise be considered as high, since the ocular tissues participate in any generalized hypersensitivity. However, it has been clearly demonstrated experimentally that there can be active tuberculous disease in the eye with high ocular reactivity to P.P.D., while the

cutaneous sensitivity is low. The probable reason for this is that, in the absence of other tuberculous lesions, a tuberculous lesion within the scleral envelope is insufficient to influence the cutaneous reactivity to any appreciable degree. Another possible explanation would be that the increased vascularity in the eye, produced by the local lesion, may be responsible for the increased local reactivity. These two explanations are of academic interest rather than clinical importance.

G. Brucella

The diagnosis of chronic brucellosis can be made only on an evaluation of a number of factors. These are the history, the present symptomatology, the exclusion of other etiologic factors, the presence of certain immunologic tests—the agglutination reaction, the complement fixation reaction to Brucella antigens, the opsonocytophagic index against living Brucella organisms, and the cutaneous reactivity to Brucella bacterial fractions. Table 1 from Huddleson gives a summary of the usual interpretation of these serologic reactions:

chronic brucellosis—nummular keratitis and recurrent uveitis—occur as a rule rather late in the chronic disease, and occur usually in individuals with a relatively high degree of cutaneous sensitivity. These patients appear to do phenomenally well under vaccine treatment which tends to lessen or abolish the sensitivity at the same time it immunizes.

The cutaneous sensitivity in brucellosis is determined by the intracutaneous injection of either brucellin or brucellergin, preferably the latter. Brucellin is the filtrate of a 20-day-old broth culture of one of the Brucella strains, Br. melitensis, Br. abortus, Br. suis, sterilized and preserved. Brucellergin is the protein nucleate fraction from all three strains. Theoretically, and indeed in practice, brucellergin gives more precise and specific reactions than brucellin.

In actual practice, 0.1 cc. of either brucellin or brucellergin is injected in the flexor surface of the forearm, with proper controls. The reaction is a delayed one of the tuberculin type and is read at the end of 24 and 48 hours. Positive reactions are erythema, edema, and induration from 2 to 10 cm. in

TABLE 1

Summary of usual interpretations of serologic reactions to Brucella antigens*

Agglutination Test	Allergic Skin Test	Opsonocytophagic Power to Blood	Status Toward Brucella
−	−	Zero to 20 percent of cells, slight	Susceptible
−	+	Zero to 40 percent of cells, marked	Infected?
+	+	Zero to 40 percent of cells, marked	Infected
−	+	60 to 100 percent of cells, marked	Immune
+	+	60 to 100 percent of cells, marked	Immune

* From Huddleson.

The test for cutaneous sensitivity becomes positive relatively late in the disease, and may be present when the agglutination titer has fallen to zero. Once positive, the cutaneous reactivity may persist for years. The relation of sensitivity to the course and type of the lesions has never been worked out in brucellosis to the same extent it has been in tuberculosis. It is noteworthy, however, that the ocular symptoms associated with

size and may often persist for a period up to 5 to 7 days.

Treatment of Allergy of the External Eye

The cardinal principles of treatment of external allergic disorders of the eye are (1) isolation, (2) specific desensitization, and (3) adjuvant therapy. If the specific allergen responsible for the hypersensitive re-

action is known, the first objective in treatment is isolation of the patient from the offending allergen. If this is impossible, then specific desensitization must be considered. Adjuvant treatment is the use of local palliative measures, washes to remove secretion and promote cleanliness, weak astringent collyria to control the tearing and prevent secondary infection, the use of various antihistamine preparations to give symptomatic relief in the anaphylactic type of reaction, and the use of beta irradiation to clear up the large follicles of vernal catarrh.

1. Isolation

The isolation of the patient from the offending allergen may be sufficient to give complete relief and so avoid the tedious and oft-repeated courses of desensitization. Once the specific compound, pollen, animal dust, feathers, cosmetics, or what not, has been identified, the condition is carefully and fully explained to the patient. It is amazing how often a simple readjustment of life may solve the problem.

Thus the patient sensitive to certain pollens takes his vacation during the local season and moves to another environment where the pollen is not present; a patient sensitive to feathers uses a glass floss or hair pillow, gets rid of the pet canary, and eats, sells, or gives away his chickens; the woman hypersensitive to a face powder or certain cosmetics changes her brand to one of the many free of orris root or such substances; the individual sensitive to cat or horse dander shuns cats and horses as he would the plague. These examples may be multiplied endlessly.

The essence of treatment here is accurate diagnosis—the detection of the offending allergen. With all the various pollens, dusts, epidermals, and so forth, it is evident that this is always difficult, and at times may be impossible. Yet the experienced allergist frequently shows the ingenuity of a Sherlock Holmes, and at times it appears almost miraculous when the answer is produced. It must be remembered, however, that isolation therapy can be applied only to patients hypersensitive to the air-borne and epidermal allergens. Patients hypersensitive to bacterial allergens have no method of avoiding contact with the common pathogens.

2. Specific desensitization

A. Nonbacterial allergens. Specific desensitization is a long and laborious procedure. Some people may be almost impossible to desensitize. Even when successfully accomplished there is a great tendency for the sensitivity to return, and the successfully desensitized patient must be kept under observation, repeatedly tested for a return of the sensitivity, and treatment instituted either annually, or on recurrence of the cutaneous reactions or symptoms.

Desensitization with the pollens, dusts, inhalants, foods, epidermals, and so forth is primarily the problem of the allergist. In view of the somewhat unsatisfactory results of such desensitization therapy in the treatment of external ocular allergy, the ophthalmologist and internist are probably wisest to advise desensitization only when the condition cannot be controlled by isolation and the adjuvant therapy of local washes, collyria, and antihistamine drugs.

If desensitization with the spores, pollens, inhalants, or even the foods is indicated, the general principle is to make up the desensitizing extract in a strength so that the initial dose (0.1 cc.) contains each of the various antigens to which the patient reacted, in a maximum of one hundredth or one thousandth the dose producing a cutaneous reaction.

Thus, for a patient reacting to 0.1 cc. of a 1:1,000 giant ragweed dilution, 1:100 Bermuda grass, and 1:10 orchard grass, the desensitizing treatment extract would contain these allergens in such strength that 0.1 cc. of the treatment vaccine would contain the equivalent contained in 0.1 cc. of a

1:100,000 dilution of giant ragweed, of a 1:10,000 dilution of Bermuda grass, and a 1:1,000 dilution of orchard grass. However, there is often no parallelism between the cutaneous and systemic reactivity of the patient to the allergens, and it is essential that there be no constitutional reaction to either the initial or to subsequent injections. Therefore, in the case of some individuals, the initial dose may be 1:10,000 or occasionally 1:100,000 of the test cutaneous dose.

The initial dose of the mixed allergens is 0.1 cc. The injections are given subcutaneously every four days and increased 0.1 cc. at each dose until a dose of 0.9 cc. is reached. A dilution 10 times the strength of the original preparation is then used, the initial dose again being 0.1 cc. and again is increased to 0.9 cc. when a 10 times stronger dilution is used. This is repeated until a concentration 100 times, and occasionally 1,000 times, the concentration of the original mixture is attained. After a dose of 0.9 cc. of the highest concentration is reached, this dose should be repeated first at weekly intervals, and then at biweekly intervals for an indefinite period, even years. Certainly this maintenance dose should be repeated as long as there is any suggestion of symptoms or activity; otherwise the sensitivity will almost certainly return.

B. Bacterial allergens. The question of desensitization with bacterial extracts and vaccines is quite different from desensitization with air-borne allergens. In bacterial hypersensitivity, isolation from the incriminated bacteria is usually impossible, and the physician has little else to offer the patient except desensitization and some adjuvant therapy. Desensitization in bacterial hypersensitivity should therefore be advised when palliative or adjuvant therapy is insufficient, when the severity of the ocular condition justifies such treatment, and when the promise of success is insufficiently great to make the effort worthwhile.

There are two allergic conditions of the external eye which fulfill these criteria. These are the dry irritative conjunctivitis associated with staphylococcus-toxin hypersensitivity and phlyctenulosis associated with tuberculin hypersensitivity. The use of other bacterial fractions or vaccines in other forms of allergic conjunctivitis or keratoconjunctivitis is of too uncertain outcome to warrant their use unless the disease is of unusual severity and all other possible methods of therapy have been exhausted.

STAPHYLOCOCCUS TOXIN. Desensitization with staphylococcus toxin is accomplished by the repeated intracutaneous injection of the toxin. In patients with an initial reaction not over 8 by 8 cm. to the 1:100 dilution, the 1:100 dilution is the first strength used. If the patient reacts definitely to the 1:1,000 dilution, or gives a greater than 8 by 8 cm. reaction to the 1:100 dilution, a weaker dilution (1:1,000) is used for the initial treatment. A dose of 0.1 cc. of the first dilution is given every four days until the patient no longer gives repeated reactions to this amount. The strength is then increased to the next stronger dilution—1:10 or 1:100 as the case may be, until again the patient no longer reacts to the injection.

Thus, the strength of the toxin is increased and treatment continued until the patient tolerates 0.1 cc. of a 1:10 dilution, or in exceptional cases to 0.1 cc. of the pure toxin without reaction. This is regarded as the final point of desensitization.

A patient may react violently to one injection, and later injections give only a minimal effect. After the point of desensitization is reached, a weekly dosage of 0.1 cc. of the 1:10 dilution should be given at weekly intervals for a period of at least six months to maintain desensitization and prevent the recurrence of the sensitivity which otherwise so often occurs.

PHLYCTENULES WITH TUBERCULIN. The treatment of phlyctenules with tuberculin is identical with the treatment of tuberculous uveitis with the same agent and is discussed below.

3. ADJUVANT THERAPY

A. Local washes and collyria. In allergic

reactions of the external eye there is frequently a good deal of lacrimal secretion and discharge. The object of washes is to cleanse the eye and prevent the matting of the lashes with the dried secretion. This is best accomplished by the use of bland washes, warm physiologic saline, or warmed 2-percent boric-acid solution. The dried crusts along the lids may be removed by gently swabbing the lid margins with a cotton swab moistened in the wash. If the crusts are adherent, they may be readily loosened by moistening the lid margins with a saturated solution of bicarbonate of soda. The secretion and congestion may be partially controlled by the use of an astringent collyrium containing also a small amount of epinephrine hydrochloride.

B. Antihistamine therapy. The toxic symptoms of the anaphylactic reaction are quite similar to those caused by histamine. The reaction is therefore usually considered due to the liberation of histamine or a histaminelike substance which acts directly on the fixed cells. The obvious direct therapy would therefore be the use of drugs which would either neutralize or prevent the toxic action of the histamine or histaminelike substance.

In 1937, drugs with such an antihistamine action were isolated in the Pasteur Institute in Paris, but they were too toxic for human use. Later derivatives were prepared which had a diminished toxic action. Since then, pharmacologists in France, Switzerland, and this country have improved and modified these early antihistaminic drugs with the result that there are now available at least eight such preparations—Benadryl, Pyribenzamine, Hydryllin, Histadyl, Thenylen, Theophain, Neo-Antergan, and Antistine. Most of these compounds have the same general chemical structure, the basic radical being either two phenyl rings, or a benzyl, anpyridyl, a thiodiphenyl, or a thiophenyl group.

Experimentally it has been found that these antihistaminic drugs prevent the action of histamine in contracting smooth muscle, inhibit the fatal effect of lethal doses of histamine in guinea pigs, diminish the pressor action of histamine on blood pressure, prevent or decrease the capillary permeability which normally follows the absorption of histamine, reduces the urticarial whealing which follows the intracutaneous injection of histamine, and are more active in preventing anaphylactic shock than are comparable doses of papaverin and epinephrine.

The antihistamines all have a definite anesthetic action; thus Antergan is 3.3., Benadryl 2.5., Antistine 1.5 times as effective as similar strengths of procaine.

Clinical investigations have shown that these antihistamines are of great value in the control of skin irritability, urticaria, the itching which accompanies dermatitis of various types, the skin eruptions which often follow sulfonamides, antibiotics, and organic extracts, and the nasal and ocular symptoms of hay fever and perennial rhinitis. The results in the treatment of bronchial asthma and asthmatic bronchitis have not been too favorable. Hydryllin (a combination of Benadryl and Amnophyllin) and Neo-Antergan have been the most effective in this regard.

There may be various unpleasant side effects with these drugs. Chief of these are drowsiness, dizziness, weakness, tremor, headache, nausea, diarrhea, anorexia, and so forth. It is notable, however, that different drugs react differently in different individuals, both as concerns therapeutic effect, and unpleasant side reactions. It is therefore possible, in any given case, to switch from one preparation to another, seeking the preparation that in the individual patient will give the maximum of therapy combined with the minimum of side effects.

The doses of these various antihistamines vary from 25 to 500 mg. daily for adults, the average effective dose being 50 mg., 3 to 4 times daily. The drugs can be applied topically, in solutions or ointments.

The manner whereby these antihistaminic drugs counteract the action of histamine is not fully understood. Certainly it does not appear to be a direct neutralization or detoxification of histamine, or a prevention of the

antigen-antibody union which leads to the liberation of histamine. Rather, it appears that the antihistaminic drugs are absorbed at the site of action of histamine and so prevent or diminish the absorption or action of histamine on the same cells. In other words, these drugs compete with histamine for position in the target cells, and by occupying these cells block off the absorption and resultant action of histamine.

The effect of the antihistamine drugs in the anaphylactic and pollen types of hypersensitivity has been fairly well established. Little or nothing is, as yet, known of any deterrent action these drugs may exert in allergic reactions resulting from bacterial type of hypersensitivity. It may well be that they may influence profoundly the basic allergic reaction of nongranulomatous uveitis, or depress the inflammatory, caseating reaction in granulomatous uveitis. There is, as yet neither experimental nor clinical evidence of this. There is, however, sufficient evidence to indicate the use of these compounds in external ocular allergy of the anaphylactic type.

In the first two types of allergic conjunctivitis—that is, the sudden, edematous type associated with hay fever, and the edematous type of blepharoconjunctivitis associated with drug allergy—the use of antihistamine drugs is clearly indicated. In the hay-fever type, the usual treatment is 50 mg. of Pyribenzamine, three times daily by mouth. The local symptoms are best controlled by an astringent collyrium containing epinephrine hydrochloride. In the greater number of cases both the nasal and ocular symptoms can be well controlled by such treatment.

In the eczematous blepharoconjunctivitis associated with drug reactions, the itching is often intolerable. In addition to the oral administration of antihistamine drugs, the local use of these compounds may be of value. The one most frequently used is Antistine, which comes prepared in a 0.5-percent solution for ophthalmic use. In a number of cases, this gives effective symptomatic relief when all other collyria fail. How much of the relief is due to the anesthetic action of the drugs is, however, difficult to say.

Since little is known of any effect the antihistamine drugs may exert in bacterial hypersensitivity, there is little indication to use the drugs in the conjunctivitis secondary to staphylococcus-toxin sensitivity. Nevertheless, the use of Antistine locally sometimes appears to control the itching and discomfort. It is quite probable that this action may be due to the anesthetic rather than the antihistamine action of the drug.

In the other manifestations of external ocular allergy—phlyctenules, marginal corneal ulcers, vernal catarrh—there appears to be no indication for the use of antihistamine drugs, although the use of Antistine to control the local itching and discomfort, which so often accompanies vernal catarrh, might be worthy of trial.

C. Beta irradiation in vernal catarrh. Excellent results are obtained in both the palpebral and bulbar forms of the vernal conjunctivitis by irradiation with the beta rays of radium. This form of irradiation is applied preferably with the radon beta applicator described first by Burnam. This is, however, obtainable only in large medical centers where there is a large concentration of radium.

In vernal conjunctivitis almost equally good results can be obtained by the use of the flat radium applicator described by Iliff, containing 50 mg. of radium. This is now available commercially. These applicators give off both the beta and the gamma rays. However, the skin erythema dose (H.E.D.) of the beta rays is 18 gram seconds, while the H.E.D. dose of gamma rays is 8 gram minutes. This differential permits the administration of the full therapeutic dosage of beta, 12 gram seconds, while only a minute amount of gamma is given.

The beta rays penetrate tissue only 2 to 3 mm. They have no effect in the irradiated tissues unless absorbed, their zone of action,

therefore, being limited to a depth of 2 to 3 mm. Their action is essentially an ionization or destructive action in the irradiated tissue. However, some tissues are more sensitive than others, especially rapidly proliferating tissues, embryonic tissue, proliferating capillary endothelium, germinal epithelium and certain neoplasms.

This form of irradiation therapy is especially efficacious against the follicles of vernal catarrh and more so against newly formed fresh follicles than against the older organized pavement-stone vegetations. In vernal catarrh, therefore, it is sometimes wiser to excise the older fibrous follicles before irradiation.

If the Iliff applicator is used, a mechanical holder for the applicator is needed on account of the long duration of treatment. While the applicator holds 50 mg., the effective output is only 30 millicuries. The length of exposure needed to obtain any given number of gram seconds is determined by the following formula:

$$\text{No. sec. exposure} = \frac{\text{No. gm. sec. treatment desired} \times 1{,}000}{\text{millicuries of radon}}$$

Thus, with an effective output of 30 millicuries, and a desired treatment of 12 gram seconds, 6 minutes and 40 seconds exposure is needed: $\frac{12 \times 1{,}000}{30} = 400$ seconds.

In actual practice, the patient is seated comfortably in a reclining chair with a head rest; the eye is anesthetized with 0.5-percent pontocaine solution; the lid to be treated is everted and held with a clamp or hook. The radium applicator, held in a mechanical holder, is then approached to the lid just short of contact, and a treatment of 6 minutes and 40 seconds given. Two areas in the same lid may be treated consecutively. Treatments are not given oftener than every two weeks to avoid any cumulative effect.

With the Burnam applicator, the treatment is much shorter. This applicator may hold as much as 500 millicuries of radon, all of which is effective. The time of exposure is calculated as above. Thus with 500 millicuries in the bulb, only 24 seconds' direct application would be the full therapeutic dose.

With the Burnam applicator, the follicles, of vernal catarrh are best treated by the "spray" method. In this method the applicator is held by hand about 1 to 3 mm. from the conjunctival surface, and moved slowly back and forth over the area to be treated. Since no one area thus receives the full irradiative effect, the exposure time may be safely increased 50 percent, or a total of 18 gram seconds given over the entire lid. Treatment should not be repeated oftener than every second week. In early cases, where the follicles consist of lymphoid cells, young fibroblasts, and blood vessels, 2 or 3 treatments may be sufficient to obtain an almost complete resolution. In more advanced cases where there is a good deal of fibrosis, more prolonged treatment may be needed.

Treatment of Allergy of the Internal Eye

The allergic reactions of the internal eye are dependent upon a hypersensitivity of the uveal tract either to one of the organ-specific ocular tissues, or to bacteria or bacterial fractions. The treatment of the allergic phase of the disease by desensitization would be in some instances (nongranulomatous uveitis, endophthalmitis phaco-anaphylactica) a direct attack on what is believed to be the actual cause of the disease, seeking to cure the disease and prevent recurrences by removing the cause.

In other instances (granulomatous uveitis, sympathetic ophthalmia) desensitization therapy would be directed only to the removal of the allergic factor which influences unfavorably the course of the disease. The actual cure of the disease would result

only from treatment with antibiotic or chemotherapeutic agents, or the control and destruction of the specific exciting organisms by the normal body defenses.

Desensitization with organ-specific tissue extracts

A. Uveal pigment. Parenteral injections of uveal pigment have been employed in the treatment of sympathetic ophthalmia with the idea of abolishing the phase which appears to set the stage for the outbreak of disease and to determine its histologic picture. The obvious criticism of such treatment is that the pigment in its present preparation is highly insoluble, is very slowly absorbed, and that the pigment sensitivity will probably fade spontaneously before it could be affected by parenteral injections. There is much truth to such criticism. Nevertheless, in the over-all picture, the cases of sympathetic ophthalmia so treated do appear to have done somewhat better than might have otherwise been expected, and to have stood later operations more successfully than would ordinarily have been hoped for.

In actual practice, the 0.5-percent standard suspension of uveal pigment is used. The injections are given at four-day intervals, intramuscularly in the buttocks or deltoid. The first injection is 0.5 cc., the second 1.0 cc., then 1.5 cc., 2.0 cc., 2.5 cc., 3.0 cc., 3.5 cc., and 4.0 cc. The 4-cc. dose is repeated at four-day intervals usually for a period of three months, or until the disease appears burned out.

Pigment therapy is accompanied by a marked increase in the opsonocytophagic index for pigment, and there are evidences of a high degree of phagocytosis of pigment in the diseased eyes (excised iris specimens). This may account for its apparent therapeutic action as well as desensitization.

B. Lens protein. Lens protein is a complex antigen, containing at least two organ-specific globulin fractions and one albumin fraction. It is an excessively weak antigen and, even in heterogenous species of animals, specific antibodies are produced only with great difficulty. For that reason, in therapy with lens protein, the principle of synergistic action of antigens has been employed. This consists in combining the weak specific antigen with a stronger nonspecific antigen in order to enhance the antigenic action of the weak antigen.

In actual practice in order to desensitize a patient found hypersensitive to lens protein, a mixture of lens protein and staphylococcus toxin is used. To 9.9 cc of the 2-percent lens protein is added 0.1 cc. of undiluted staphylococcus toxin. This gives a 1:100 concentration of toxin in the lens protein. The initial dose is 0.1 cc. given intracutaneously and this dose is repeated every four days, until the patient no longer shows a reaction.

At this point the patient is tested with 0.1 cc. of the 2-percent lens protein solution. If there is no reaction, desensitization is considered accomplished. If there is a reaction to the lens protein, the patient is then tested with a 1:100 dilution of staphylococcus toxin. If negative to this, he is tested with a 1:10 staphylococcus toxin, and finally to straight toxin, until a dose of toxin is found to which he does react.

A new lens protein-staphylococcus mixture is now made up, containing the reactive dose of toxin, and treatment is continued until the patient no longer shows any cutaneous reaction to an injection of lens protein alone. This is regarded as the point of desensitization. The staphylococcus toxin-lens protein is readily absorbed, and desensitization is usually quickly and readily accomplished within 3 to 6 weeks.

Desensitization with bacterial antigens

The principle of desensitization with bacteria or bacterial extracts is (1) the determination, with the greatest possible exactness, of the specific organism responsible for the hypersensitivity; in the case of bacteria with many antigenically distinct strains, this

involves the further determination of the strains involved; (2) the preparation of the vaccine from the proper strains and also from the proper fractions of the antigenic mosaic; (3) the decision of the proper manner of administering the vaccines, intracutaneous, subcutaneous, intramuscular, or intravenous; (4) the careful observation of the patient during the period of treatment, in order that the dose may be kept below the point of reactivity and increased as the reactivity recedes.

The streptococci and gonococci are the important organisms concerned in nongranulomatous uveitis, and the Mycobacterium tuberculosis and Brucella organisms are the important ones in granulomatous uveitis. In syphilis there is no antigen available to determine hypersensitivity to the Treponema pallidum. There are doubtless many more other exciters of granulomatous and nongranulomatous uveitis, but they are either unknown, or there is no means of testing for hypersensitivity to them.

A. Streptococcus vaccine. The indications for the use of a streptococcus vaccine are (1) that the clinical condition be a nongranulomatous uveitis; (2) that there are clinical evidences of systemic nongranulomatous disease (rheumatoid arthritis, a chronic focus of infection, and so forth) or a history of a former nongranulomatous infection with some suggestive time relationship to the ocular disease; (3) that other obvious causes for the ocular disease are eliminated; (4) that the bacterial hypersensitivity demonstrated is specific and is greater than shown by normal controls, and not part of a general reaction to all bacterial antigens.

The route of administration of streptococcus vaccine is of great importance. Experimental work indicates that the subcutaneous administration of killed streptococci often tends to increase the tissue hypersensitivity, while the intravenous administration tends to desensitize.

Wainwright utilized this finding in the vaccine treatment of rheumatoid arthritis, using the intravenous route for the administration of the streptococcus vaccine. This same principle has been followed in the desensitization for nongranulomatous ocular disease. On the basis of the results so far obtainable, all the "successes" have followed this method of administration, while no improvement has been observed after subcutaneous injections. The intravenous administration therefore appears the method of choice with streptococcus antigens.

Since the hypersensitivity produced by streptococci is dependent upon the acid-soluble proteins of the bacterial body, the vaccine must be prepared from the bacterial bodies themselves. The individual strains are grown in broth for 24 hours, the organisms killed by heat, the bacterial bodies thrown by centrifugation, washed in saline to get rid of any trace of broth or exotoxin, and are finally taken up in salt solution, the concentration adjusted to T-50 on the spectrophotometer, 0.5-percent tricresol added, and this stock suspension cultured for sterility.

The first treatment vaccine should contain the organisms in one-tenth the concentration to which the patient reacted intracutaneously. Since the test vaccine was a 1:10 dilution of the stock T-50 concentration, the "first strength" treatment vaccine should be the pooled 1:100 dilutions of the T-50 stock concentrations of the various strains to which the patient reacted. The second strength treatment vaccine is the pooled 1:10 dilutions of the same T-50 stock concentrations, while the third strength is the straight pooled T-50 stock concentrations of the same strains. After the vaccines are prepared 0.5-percent tricresol is added, and the vaccines are tested for sterility.

The first intravenous dose is 0.1 cc. of the "first strength" vaccine. If there is no general reaction (malaise, fever, leukocytosis, and so forth) the dose is repeated at four-day intervals, and increased 0.1 cc. at each injection until 0.9 cc. is reached. The second strength is then similarly administered. This is con-

tinued in a similar manner until the patient receives 0.9 cc. without reaction. The third strength vaccine is now given and the dose then repeated weekly as a maintenance dose.

After the early injections, the patient should be carefully observed, his temperature followed for 24 hours, and a leukocyte count done four hours after the injection. If the patient shows a reaction to the initial dose of 0.1 cc. of the first vaccine preparation, the preparation is then diluted 10 times, and 0.1 cc. again similarly administered. Thus there is determined an original dose below the patient's individual point of reactivity. This is then accepted as the proper starting dose, and the dosage thereafter is increased as outlined above. In the event of a general reaction, or focal reaction in the eye being observed during the course of desensitization, the dose is dropped to one-tenth or one one-hundredth the amount given before the general or focal reaction, and again increased from this point.

The question of how long such treatment should be continued is an interesting one. Since this form of therapy has been used in selected cases in the Wilmer Institute of The Johns Hopkins Hospital, several cases have been encountered which showed the same general picture. Prior to the administration of the streptococcus vaccine the patients had had repeated violent attacks of nongranulomatous uveitis. During vaccine therapy they were free from attacks. Within 3 to 6 months after stopping treatment, the attacks recurred, and the sensitivity to the specific streptococci returned. Further treatment was again followed by freedom from attacks. In actual practice, after the point of apparent desensitization has been reached, it would seem wise to continue the treatment at weekly intervals.

B. Gonococcus vaccine. The indications for the use of a gonococcus vaccine are that the patient have a recurrent nongranulomatous iritis, which from the history and associated findings appears to be of gonococcal origin, that he also shows a cutaneous hypersensitivity to gonococci, and that other methods of treatment have been inefficacious in controlling the inflammation or curtailing attacks.

The best route of administration, subcutaneous or intravenous, is unknown. In view of this uncertainty, the wisest course is to adopt the simplest method and administer the vaccine subcutaneously.

The vaccine for treatment should be prepared from the type to which the patient showed the greatest reaction. Commercial stock vaccines may be used if the patient shows an equal sensitivity to them. The original concentration of a prepared vaccine should be one tenth of that to which he showed a cutaneous reactivity. The original dose is 0.1 cc. The injection should be given every third or fourth day, and increased in the usual manner until a dose of 0.5 cc. of a T-500 concentration is reached. A small group of such cases treated in this manner have shown a favorable course. This is all that can be said.

C. Other organisms. If it is decided to use a vaccine prepared from an organism isolated from a focus of infection in the patient, the vaccine should be prepared as used or described for gonococcus vaccine.

D. Tuberculin treatment. Treatment with tuberculin is essentially desensitization therapy. Old tuberculin or one of its many variants is used. Denys' Bouillon Filtrate (D.B.F.), a glycerinated 1:10 dilution of O.T. has certain advantages. Bacillen emulsion is to be avoided on account of the irregularity of dosage that occurs in higher dilution.

For treatment, the D.B.F. is prepared in nine different strengths—No. 1 represents the undilated D.B.F.; No. 2, a 1:10 dilution; No. 3, a 1:100 dilution; No. 4, a 1:1,000 dilution; and so on to No. 9, which is a 1:100,000,000 dilution of the D.B.F., or 0.000,001 mg. to the cc. Thus, 0.1 cc. of the various dilutions represents the following dosages:

Dilution	Dosage
No. 1—straight D.B.F.	0.1 cc. = 100 mg.
No. 2—1:10	0.1 cc. = 10 mg.
No. 3—1:100	0.1 cc. = 1 mg.
No. 4—1:1,000	0.1 cc. = 0.1 mg.
No. 5—1:10,000	0.1 cc. = 0.01 mg.
No. 6—1:100,000	0.1 cc. = 0.001 mg.
No. 7—1:1,000,000	0.1 cc. = 0.0001 mg.
No. 8—1:10,000,000	0.1 cc. = 0.00001 mg.
No. 9—1:100,000,000	0.1 cc. = 0.000001 mg.

In actual practice, the initial dose is usually 0.1 cc. of the No. 8. In the extremely sensitive, it is wiser to start with 0.1 cc. of No. 9, or occasionally with a No. 10 dilution. Injections of dilutions 9, 8, 7, 6, and 5 are given twice weekly, or at four-day intervals. The initial dose of each dilution is 0.1 cc. Subsequent doses are 0.2 cc., 0.3 cc., 0.4 cc., 0.6 cc., and 0.8 cc. When 0.8 cc. of a dilution is reached, the next higher dose is 0.1 cc. of the next higher concentration.

When 0.8 cc. of No. 5 dilution is reached, further injections are given at weekly intervals. The injections of numbers 4, 3, and 2 are 0.1 cc., 0.2 cc., 0.3 cc., 0.4 cc., 0.5 cc., 0.6 cc., 0.7 cc., 0.8 cc., and 09 cc. When a dosage of 0.5 cc. of No. 2, or 50 mg. is reached, the dose is not increased further. This dosage should, however, be repeated at weekly intervals for a minimum period of two years as a maintenance dose, to prevent the recurrence of the hypersensitivity which, without maintenance of treatment, is so prone to occur.

During tuberculin treatment, the patient should be carefully watched both for local reactions at the site of the injection and focal reactions in the eye. In the event of a local reaction (erythema, induration) at the site of the injection, the dose should be dropped three levels, and increased only when no local reaction is observed. If there is a focal reaction—that is, a lighting up of the inflammatory process in the eye—the dose is dropped to one tenth of the dose which produced the focal reaction (the same dose of the next weakest dilution), is again repeated at this level, and is only increased when the focal reaction has subsided.

It should be emphasized that there is no such thing as an absolute dose of tuberculin for any one individual. The essential point of desensitization therapy with tuberculin is to keep the dose beneath the patient's point of reactivity, and to increase the dosage only as the point of reactivity recedes.

D. Brucella vaccine. The three known strains, Br. meletensis, Br. suis, and Br. abortus are certainly all closely related antigenically, all containing varying amounts of identical antigens. They are thus so closely related antigenically that a single vaccine can be used for treatment.

Various preparations have been suggested, the best known being the Brucellin of Huddleson and oxidized vaccine of Foshay.

Brucellin is the mixed clear filtrate of 20-day-old cultures of the known strains. It is adminstered intracutaneously with the idea of evoking general systemic allergic reactions, and it is considered that 3 to 4 such reactions are necessary to produce any therapeutic effect.

The usual procedure is first to test the patient with an intracutaneous dose of 0.1 cc. of Brucellin. If he does not show a systemic reaction to the dose in four hours, the first treatment dose of 0.5 cc. is given. If the patient does show a systemic reaction to 0.1 cc. this is held as the treatment dose as long as the patient reacts. After the reaction dose is determined, this is repeated at three-day intervals until the patient has had three or more systemic reactions.

Thereafter, the dose is spaced to 15-day intervals and so continued for six months, together with any other supportive treatment (antibiotics, sulfa compounds, and so forth) desired. Advocates of this treatment claim about 25 percent of the chronic cases are benefited. This would appear to be a high figure, and it is somewhat doubtful if the low incidence of improvement warrants the severe systemic reactions entailed.

Various other vaccines, bacterial extracts, and suspensions have been prepared for the

treatment of chronic brucellosis. In the effort to produce a vaccine with a maximal reduction of toxicity and a minimal loss of antigenicity, Foshay has prepared an oxidized Brucella vaccine.

This vaccine is prepared by growing a smooth abortus strain of established antigenicity on solid media or a fortified tryptose broth. The organisms are harvested, killed with formaldehyde, the turbidity adjusted to about T-1,000 in the spectrophotometer, and the organisms then oxidized by taking them up in 30-percent aqueous sodium nitrite, 5 ml. to each 3 ml. of packed bacterial sediment together with 5 ml. of 30-percent acetic acid; the mixture is stored in centrifuge tubes, carefully marked for original volume, and the organisms are thus oxidized 4 to 5 hours at room temperature. Acids and salts are then removed by repeated washings and centrifugation and the oxidized bacteria finally taken up to the original volume in 0.5-percent phenolized saline.

In treatment, four strengths of the vaccine are prepared: T-1, T-5, T-50, and T-500. The initial dose is 0.1 cc. of T-1. The patient is watched carefully for any evidence of systemic reactions. If none are observed, the doses are repeated every second day, and increased 0.1 cc. at each injection until a dose of 0.5 cc. is reached. The concentration of the vaccine is then increased to T-5, and 0.1 cc. is given. This is likewise increased 0.1 cc. at each dose until a dose of 0.9 cc. is reached. The concentration is then increased to T-50, the initial dose is again 0.1 cc., and it is increased as before until a dose of 0.9 cc. is again reached.

If there have been no reactions, the concentration is increased to T-500 and 0.1 cc. again given. This is increased in like manner until a dose of 0.5 cc. is reached. This is continued twice weekly for two months when the blood should be examined for the opsonocytophagic index.

In the treatment of patients with chronic ocular brucellosis, the vaccine is always administered with the idea of keeping the dose below the patient's point of reactivity and avoiding all local, focal, or systemic reactions. If there is any systemic or focal reaction at any level, the dose is immediately reduced to one-tenth the amount causing the reaction, and again cautiously given as usual. The treatment is continued until the opsonocytophagic index shows marked phagocytosis in at least 90 percent of the cells. This development of a high opsonic index is almost invariably accompanied by a diminution in the cutaneous sensitivity.

It is interesting that frequently the patients volunteer the information of improvement in their general health and sense of well being while under treatment. It is not clear whether the local therapeutic effect in the eyes is due to the immunity acquired or produced by the vaccine treatment, or is the result of tissue desensitization. It is interesting, however, that the ocular symptoms have, as a rule, occurred in patients with high degree of cutaneous hypersensitivity.

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THE OPHTHALMOSCOPIC EVALUATION OF OPTIC ATROPHY*

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A survey of the available literature on the diagnosis of optic atrophy brings forth the familiar triad of symptoms—pallor of the disc, reduced visual acuity, and defects in the visual field. Although, in many cases, these signs permit us to diagnose optic atrophy with a considerable amount of assurance, there remain a number of cases in which they are either not available to us, as in the case of children or others unable to coöperate, or are wholly untrustworthy, as in some cases of retinitis pigmentosa.

In some of these uncertain cases, in spite of all the classical signs and symptoms including the "peculiar waxy atrophy of the disc," subsequent pathologic study has revealed no evidence of atrophy in the nerve even after the use of the myelin-sheath stain.

Most ophthalmologists will admit that the present diagnostic criteria for optic atrophy are inadequate in many cases, with the result that we are frequently forced to play a delaying game, not through any lack of training or thoroughness on our part, but simply because no purely objective method exists for the diagnosis of optic atrophy. It is the purpose of this paper to present a possible method.

Since testing visual acuity and taking visual fields are, in large measure, subjective procedures, we can immediately discount their value. There remains, then, the ophthalmoscopic appearance of the disc. Walsh states that pallor of the discs alone is not evidence of optic atrophy. Adler has summarized the opinions of numerous observers in the following statement, "pallor of the disc may be due to one or all of the following factors: low hemoglobin content of the blood, diminution in the number of capillaries on the disc, overgrowth of glial fibers and, finally, actual loss of the nerve fibers."

Of these factors, the number of capillaries on the disc facilitate ready and precise ophthalmoscopic evaluation. There are many scattered references throughout the literature pertaining to a loss of capillarity on the disc in optic atrophy but it remained for Kestenbaum, in 1946, to quantitate these small vessels and to point out their possible utility in the diagnosis of primary optic atrophy by what he calls the Kestenbaum capillary number test. To acquaint those not too familiar with this test the following portion of his book is quoted in its entirety:

> "In order to set a numerical value on the degree of atrophy, the vessels which pass over the margin of the disc may be counted. One starts at the twelve o'clock point and counts all the vessels crossing the margin, counting separately the arteries, the veins and the small vessels. 'Small vessels' mean the vessels which cannot be recognized as arteries or veins. The number of vessels passing over the margin in normal eyes is fairly constant. Without dilatation of the pupil, usually 9 large vessels (4 or 5 veins and 4 or 5 arteries) and about 10 small vessels can be seen.
>
> "Of course there are many exceptions in normal eyes. Sometimes the arteries and veins branch repeatedly on the disk, so that more than 9 large vessels pass over the disk's edge. In disks with irregular or inverse distribution of the vessels, the number test is also unreliable. In the large majority of cases, however, the arrangement of the vessels is regular enough to permit the use of this test.
>
> "In primary optic atrophy, the number of arteries and veins remain unchanged, but the number of small vessels is diminished to 7, 6 or even less, down to only 3, so that an approximate numerical measure of the degree of pallor is possible. This test may be of value in the observation of the development of the disease." (See Diagram 1.)

This paper does not claim any originality but simply tests the validity of Kestenbaum's conclusions and seeks to extend their usefulness to apply to all cases of optic atrophy from whatever cause.

* From the Massachusetts Eye and Ear Infirmary, Boston, Massachusetts. Presented before the New England Ophthalmological Society, November 16, 1948. Part of the expenses of this study were assumed by the Kresge Fund for Eye Pathology.

Procedure

An attempt was made to study all cases of optic atrophy appearing at the out-patient department of the Massachusetts Eye and Ear Infirmary, as well as the house cases on the wards of the Massachusetts General Hospital for a period of nine months. Only those cases affording a clear view of the disc were utilized.

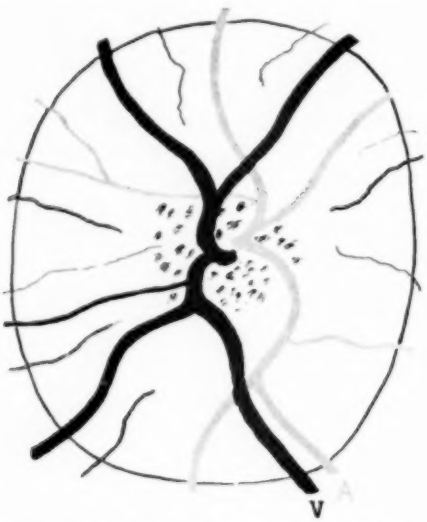


Diagram 1 (Kant). This drawing of the disc shows the "small vessels." Only those vessels which cannot be recognized as arteries or veins are counted.

The small vessels on the disc were counted according to the method elaborated by Kestenbaum. To make the method as simple and practical as possible, an ordinary electric ophthalmoscope was used. The number of vessels counted was recorded and then refraction and fields were done under comparable conditions. A number of normal eyes were similarly studied and recorded.

The patients varied in age from the 1st to the 6th decade. Of the 65 patients examined, 20 were normal and 45 showed atrophy of some type, affording a total of 125 eyes of which 49 were normal and 76 atrophic.

Etiologic study of the atrophic cases showed:

Primary atrophy, cause unknown	7
Neurosyphilis	3
Nasopharyngeal carcinoma	1
Acromegaly	1
Glioma of chiasm	1
Rolandic meningioma	1
Suprasellar cyst	1
Orbital tumor (meningioma)	1
Retrobulbar neuritis, cause unknown	1
Multiple sclerosis	3
Toxic amblyopia	2
Optic neuritis	5
Vascular occlusion	3
Chorioretinitic disease	2
Fuchs's atrophy	1
Birth injury	1
Auto accident	3
Combined systemic disease	1
Glaucoma	7

Columns for visual acuity ranging from nil vision to 20/15 were laid out and the number of small vessels counted in each case was recorded under the appropriate visual acuity found. The tabulated results were averaged giving a mean number of small vessels under each visual acuity.

Similarly, columns representing the number of small vessels from 0 to 14 were laid out. The visual fields were analyzed by means of a polar planimeter for preserved area of field expressed in square centimeters. The results thus found were tabulated under the appropriate column of the number of vessels in each case. The totals were then averaged for each column. For this study, based upon a number of determinations, an approximately full field constituted between 19 to 22 square centimeters.

It was assumed that the number of small vessels on the disc reflected the overall functional integrity of the optic nerve. Practically, in order to evaluate the nerve, we usually consider two things: namely, the central vision, as shown by the visual acuity, and the peripheral vision, as shown by the area of preserved field.

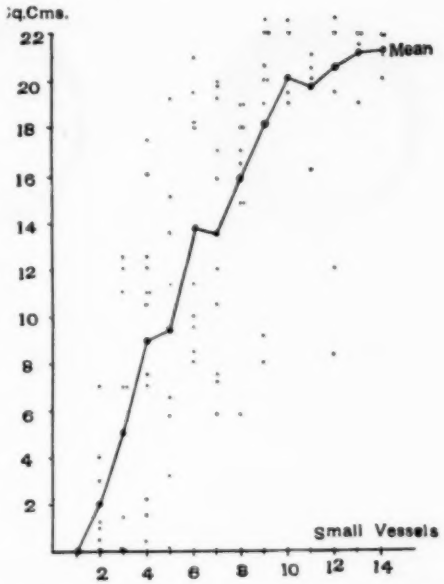
If our assumption is correct—that the number of small vessels on the disc expresses the degree of functional integrity of the nerve or, conversely, indicates the de-

gree of total atrophy present—then the larger the visual field the greater should be the number of small vessels.

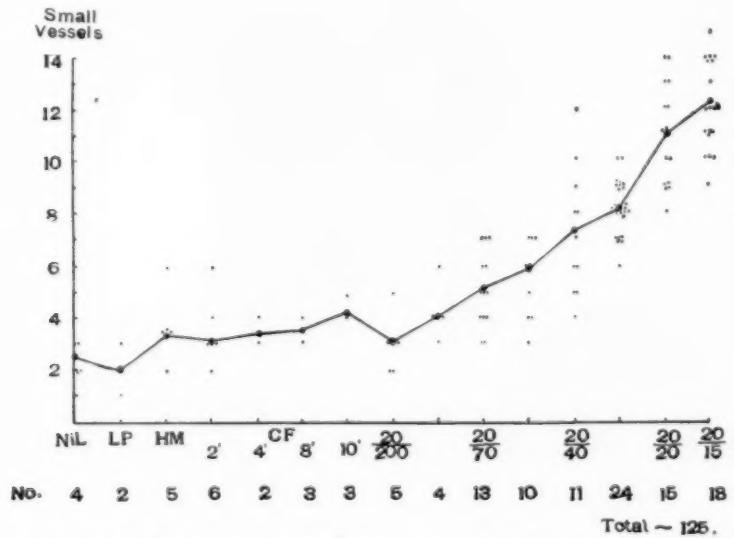
Similarly, the higher the visual acuity the greater should be the number of small vessels, provided decreases in visual acuity were part of an overall atrophy and not due to a selective atrophy involving the papillomacular bundle which could cause a drastic reduction in central vision without causing a commensurate loss in peripheral field.

Graph 1 shows the correlation between the number of small vessels and the area of preserved field expressed in square centimeters. The black dots represent the actual values found in the individual cases and the solid black line represents the mean value of area of field. It can readily be seen that a surprisingly direct relationship exists between these two factors.

Graph 2 shows the mean value of the number of small vessels counted plotted as a curve against visual acuity. The black dots represent actual values as found and the solid black line indicates the mean value of



Graph 1 (Kant). Correlation of the size of the visual field to the number of small vessels. The abscissa shows the number of small vessels; the ordinate, the preserved area. A full field is 19 to 22 sq. cm.



Graph 2 (Kant). Correlation of the visual acuity to the number of small vessels. The abscissa shows the visual acuity; the ordinate, the number of small vessels. Numbers under the acuity listings indicate the number of cases having that acuity.

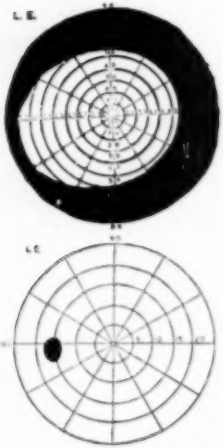


Chart 1. Visual fields for (above) 3/330 white and (below) 1/1,000 white. The patient, a man, aged 35 years, showed 13 small vessels in this eye and had a visual acuity of 20/15 and a field area of 21.5 sq. cm.

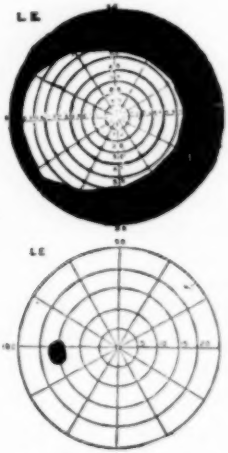


Chart 2. Field studies of the left eye of a boy, aged 10 years (above) for 3/330 while and (below) 1/1,000 white. Visual acuity in this eye was 20/20, the number of small vessels was 12, and the field area, 19.5 sq. cm.

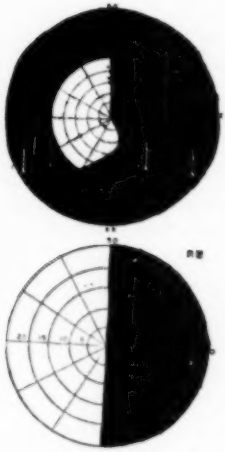


Chart 3. Field studies of the right eye of a boy, aged 16 years for (above) 3/330 white and (below) 1/1,000 and 10/1,000 white. The patient, who had diabetes insipidus, had a visual acuity in this eye of 20/40 + 3. The number of small vessels was five. Field area 5.8 sq. cm.

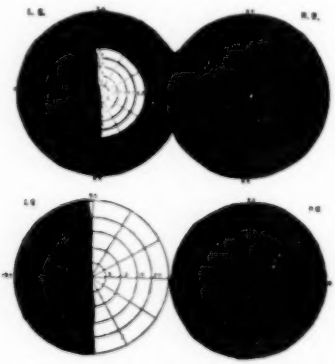


Chart 4. The patient was a woman, aged 30 years, who had 20/20—3 vision in the left eye, which showed eight vessels. The right eye was blind but showed three small vessels. (Above) Field studies for 3/330 white. (Below) Fields for 1/1,000 and 10/1,000 white. Area of field L.E., 7.2 sq. cm.

Charts 1 to 4 (Kant). The visual fields are numbered to correspond with the numbers of the Kodachromes which they illustrate.

1. NORMAL BLOND.

2. PHYSIOLOGIC PALLOR.

3. POSTTRAUMATIC.

O.S.

O.D.

4. GLIOMA OF CHIASM. RIGHT EYE (POSTSURGICAL).

FIGS. 1 TO 4 (KANT). KODACHROME ILLUSTRATIONS OF FUNDI, GIVING A SUBJECTIVE IMPRESSION OF THE DEGREE OF PALLOR OF THE DISC WHEN COMPARED TO THE SURROUNDING FUNDUS.

5. MENINGIOMA. ROLANDIC AREA. RIGHT EYE (POSTSURGICAL).

6. EMBOLISM. CENTRAL ARTERY.

7. MULTIPLE SCLEROSIS.

8. SUPERIOR PAPILLARY OCCLUSION.

FIGS. 5 TO 8 (KANT). THESE KODACHROMES, AS WELL AS THOSE IN FIGURES 1 TO 4, ARE NOT SUFFICIENTLY CRITICAL TO SHOW THE SMALL VESSELS. IN MOST INSTANCES, SINGLE EYES ARE SHOWN IN ORDER TO ILLUSTRATE THE SCOPE OF APPLICATION OF THE NUMBER TEST.

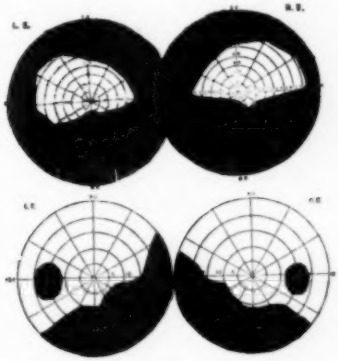


Chart 5. These field studies are for a woman, aged 40 years, for (above) 3/330 white and (below) 1/1,000 and 10/1,000 white. Vision in each eye was 20/30+. The left eye showed six small vessels and the area of the visual field was 9.5 sq. cm. The right eye showed seven small vessels and a visual field area of 10.5 sq. cm.

Chart 6. The visual acuity in the left eye of this patient, a man, aged 49 years, was hand movements temporally. The number of small vessels present was three.

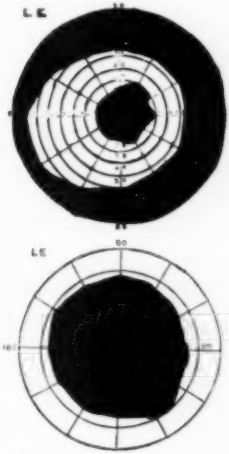


Chart 7. Visual field studies for the left eye of a man, aged 23 years, for (above) 5/330 white and (below) 10/1,000 white. Visual acuity in this eye was counting fingers at two feet; six small vessels were counted. Area of field, 18 sq. cm.

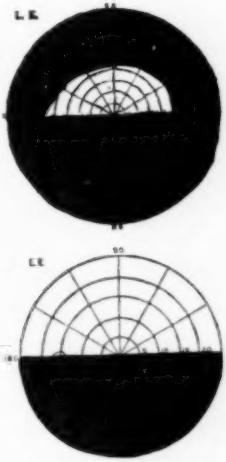
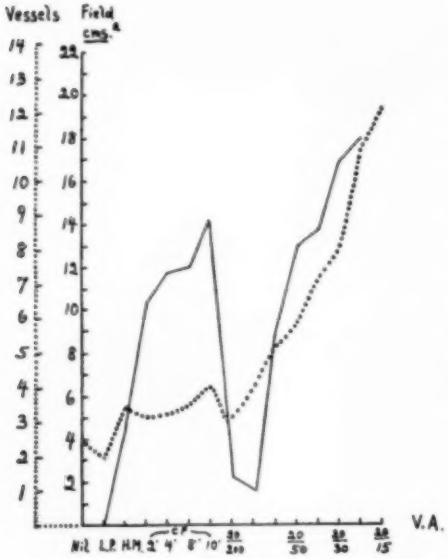


Chart 8. The left eye of this man, aged 56 years, had 20/20 vision, and the number of small vessels was eight. (Above) Field for 3/330 white. (Below) Field for 1/1,000, 3/1,000, and 10/1,000 white. The normal right eye of this patient showed 14 small vessels. Area of field L.E., 5.8 sq. cm.

Charts 5 to 8 (Kant). The visual fields are numbered to correspond with the numbers of the Kodachromes they illustrate.

these findings. The numbers under the acuity listings represent the number of cases observed under that acuity.

It can be seen that there is a surprising correlation between the number of small vessels and the visual acuity, especially between the range of 20/200 and 20/15, where an almost linear function exists. Between



Graph 3 (Kant). Correlation of visual acuity, extent of visual field, and number of small vessels. The abscissa represents the visual acuity. The solid line of the ordinate shows the area of field; the dotted line, the number of small vessels.

20/200 and nil vision the curve is less regular.

There are several possible explanations for this segment of the curve:

1. There is the subjective element of error in counting which, however, does not seem too important in view of the fact that the remaining portion of the curve is based on the determinations of the same observer.

2. Only relatively few determinations in this range of the curve were available and it is possible that, if a greater number of cases had been studied, this section might have conformed more closely to the general curve.

3. If the fibers subserving central vision were damaged to a greater extent than the peripheral ones, the visual acuity would then be expected to be low, with preservation of a relatively large field. Since the number of small vessels expresses the degree of overall atrophy, there would be present a relatively greater number of vessels than would be expected for that acuity. In effect, this is exactly what happened in these cases in this portion of the curve as is shown in Graph 3.

Graph 3, in addition, shows that there is no reliable relationship between the visual acuity and the amount of field preserved except when the atrophy is general and overall.

In those cases, and there were quite a few, in which the number of small vessels found was at variance with the amount of visual acuity, which was either inordinately high or low for reasons already mentioned, the area of preserved field closely approximated the amount expected, the data in Graphs 1 and 2 being used for mean values. These points can be illustrated by reporting a few cases.

Case reports

Case 5. A man, aged 68 years, had chronic simple glaucoma of both eyes, with marked cupping and atrophy in the left eye and slight in the right eye.

	O.D.	O.S.
No. small vessels	8	6
Visual acuity		
actual	20/30	Fingers at 5 inches
expected	20/30	20/50+
Visual field		
actual	14.8 sq.cm.	13.6 sq.cm.
expected	15.8 sq.cm.	13.6 sq.cm.

Here the right eye shows an excellent agreement between the actual and expected values both as to acuity and area of field. The left eye shows an inordinate decrease in acuity compared to the number of small vessels on the disc. In this instance, apparently, the papillomacular fibers had been severely damaged with resultant poor acuity. The remaining overall, functional integrity of the nerve is shown, however, by the

preservation of exactly that amount of field expected for a nerve with this capillary index. In this case both the ophthalmoscopic appearance of the disc and the markedly reduced visual acuity would have suggested a greater degree of total atrophy.

Case 17. A woman, aged 60 years, had chronic simple glaucoma of both eyes, more advanced in the left eye.

	O.D.	O.S.
No. small vessels	7	2
Visual acuity		
actual	20/40	20/100
expected	20/40	Light perception
Visual field		
actual	18.0 sq.cm.	1.0 sq.cm.
expected	13.4 sq.cm	2.0 sq.cm.

Here again there is a good correlation in the right eye as regards acuity and fairly good as regards field. However, in the left eye there is considerable disparity between the actual and expected acuities. In this case, apparently, the macular fibers were relatively spared. The visual fields both actual and estimated agree very closely.

From these findings one is led to the conclusion that the number of small vessels on the disc quantitatively measures the degree of functional integrity of the optic nerve or, in other words, can be used as an indicator of the degree of overall atrophy present.

It may be of interest to consider the findings in an unquestioned case of retinitis pigmentosa which had all the classical signs and symptoms including the peculiar waxy pallor of the disc so characteristic of the disease.

Case 1. A woman, aged 26 years, had a diagnosed case of retinitis pigmentosa.

	O.U.
No. small vessels	13
Visual acuity	
actual	20/200
expected	20/15
Visual field	
actual	4° fixation (0.5 sq.cm.)
expected	21+ sq.cm.

Conclusion

Either the capillary index is no measure of optic atrophy in this case, or there is no optic atrophy present.

In this connection it is interesting to note that Verhoeff, in 1931, reported a case of retinitis pigmentosa that had been blind for 20 years in which the ganglion cells were well preserved and abundant and even the myelin-sheath stain failed to show any evidence of atrophy in the nerve. By citing this case, it is not meant to imply that atrophy does not occur sometimes in this condition. However, the striking disparity in this one case between the obvious waxy pallor and the capillary index of the disc was of sufficient interest to warrant mention.

Comment

The number of small vessels is not difficult to count. However, as some of these vessels are quite minute, a little practice will improve one's recognition of them and increase the accuracy and reproducibility of the count. Separate observers, on the first trial, have agreed to within 1 to 2 vessels on the same eye.

Care must be exercised to count only those vessels which cannot be recognized as being either arterial or venous. A darkened room is to be preferred. When the accommodation is active, cycloplegia facilitates the counting considerably.

A clean, well-focused ophthalmoscope with good illumination is essential. In my experience, red-free light was not superior to ordinary light in the final count although it did make the small vessels more striking in appearance.

Noteworthy in this series were two cases of marked physiologic pallor of the disc which had been previously diagnosed as atrophy by several members of the staff. These cases, subjected to the capillary number test, fell well within the range of normal, which impression was subsequently confirmed by refraction and quantitative perimetric studies on the Goldmann perimeter.

One case of partial vascular occlusion failed to show an appropriate correspondence between the number of small vessels and acuity and fields. As far as could be determined, it did not have any anomalous vascularization of the disc.

Although the number of cases in this study is admittedly small, the results from the Kestenbaum capillary number test in optic atrophy are sufficiently suggestive to warrant further study and consideration. The capillary test can serve as an interesting adjunct and check on the more usual diagnostic tests, when these are available. In those cases in which visual acuity and field studies are impossible, for whatever reason, the capillary number test may afford the only clue to diagnosis.

Summary

In this study, 125 eyes—49 normal and 76 atrophic—were examined. The number of small vessels on the disc was counted according to the Kestenbaum capillary number test. The visual acuity and area of field were determined in each case. These findings were correlated with the number of small vessels and expressed in graph form.

Conclusion

The capillary number test as elaborated by Kestenbaum is a valuable adjunct in the diagnosis of optic atrophy from whatever cause and would seem to be a reliable measure of the degree of atrophy present.

129 Clinton Street.

I am indebted to Dr. Okamura of the Department of Pathology, Massachusetts Eye and Ear Infirmary, for the fundus photographs.

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EPITHELIAL TUMORS OF THE CILIARY BODY*

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INTRODUCTION

The significance of certain tumors of the ciliary body has been a controversial subject since Treacher Collins,[1] in 1891, first reported a case of primary tumor of the ciliary body in a woman, aged 63 years. Following Collins's report, Alt[2,3] and Fuchs[4] wrote rather extensively on the subject. Both of these authors endeavored to classify the various growths and discussed their etiology. Fuchs,[4] in 1908, reported eight cases and classified the tumors according to the microscopic morphology.

The description of some of these tumors led Collins[5] to postulate the glandular nature of the ciliary epithelium, a point which is still adhered to by some observers (Leber,[6] Rados,[7] Seidel,[8] Carrére,[9] and others).

GENERAL DISCUSSION

Most writers have agreed on the main factors influencing the classification of these primary tumors of the ciliary body. The main factors generally considered are: (1) Cell morphology, (2) age of the patient, (3) extent of growth, and (4) significant past history.

Fuchs[4] laid the greatest stress on the first factor in his classification; however, he was influenced by the second and fourth factors also. The extent of growth was of comparatively little importance in his classification.

Nordmann[10] gave less attention to the past history and gave a greater significance to the extent of growth.

For the purpose of this discussion Nordmann's classification is acceptable and will be used:

I. BENIGN TUMORS
- A—Hyperplasia
- B—Benign epithelioma (adenoma)

II. MALIGNANT TUMORS
- A—Embryonic type (dictyoma)
- B—Adult type

Collins[1] described his first case as an adenoma and numerous subsequent reports of different authors have used the same term for the small tumors originating from the ciliary epithelium. Fuchs[4] in his thorough treatise on the subject coined the term "dictyoma" (net-tumor) to describe those tumors of the ciliary body whose cells are embryonic in type.

Those tumors which show evidence that the cells are embryonic in type may even form what appears to be an embryonic retina. Often these are indistinguishable from retinoblastoma (neuro-epithelioma).

For the most part these tumors have been found only in children; whereas, the more differentiated cells are seen in adults around the age of 50 years. The large majority of the latter type have no clinical signs or symptoms referable to the presence of an intraocular new growth. These tumors have been found in globes enucleated for various reasons and have had no demonstrable influence on the condition of the ocular illness.

A comparatively large percentage of the patients who reveal these small epithelial tumors of the ciliary body have a past history of ocular inflammation so that this point has been seriously considered as an etiologic factor (Fuchs,[4] Alt,[11, 12] Duke-Elder,[13] and others). However, the percentage incidence of inflammation is not sufficiently high in these cases to render it significant statistically.

Following Nordmann's classification will facilitate the discussion of the various primary epithelial tumors of the ciliary body.

* From the Institute of Ophthalmology of the Presbyterian Hospital. Presented at the New York Academy of Medicine (Eye Section) March 15, 1948.

I. Benign tumors

A. Hyperplasia

The simple hyperplasia of the ciliary epithelium may form cell masses resembling a small neoplasm. There may be a pigmented or nonpigmented epithelial mass originating from the ciliary epithelium. Such growths usually extend toward the interior of the globe and they do not penetrate into the ciliary processes or ciliary body proper. The arrangement of the cells is usually quite irregular without evidence of any typical organization of the elements. The cells are large with oval nuclei and seem to be simply piled on one another in the form of sheets with occasional folds or scallops.

Eyes with such lesions have a long history of "eye trauma," either as a long-standing recurrent iritis or inflammation following injury. Such changes in the epithelium are frequently seen also in senile eyes. The hyperplasia in some cases may be so general as to push the iris forward and embarrass an already narrowed filtration angle. Generally, the senile hyperplasia is a proliferation of the nonpigmented epithelium but the pigment epithelium may participate in the process as well.

For the most part this hyperplasia involves the region of the ciliary processes but frequently long strands and fingerlike formations may extend from the pars plana (Salzmann).

Case 1

History. A 40-year-old man was struck in the eye during childhood. Following the injury the eye gradually became blind. On occasions the eye became injected with moderate discomfort. Symptoms were not sufficiently severe to consult an ophthalmologist until three weeks prior to admission. At the time he was first seen the eye was painful and exhibited marked ciliary injection, the cornea was steamy, and the tension markedly elevated. Clearing of the cornea revealed a cataractous lens with iris bombé. The eye was excised with a clinical diagnosis of absolute glaucoma, secondary to detachment of the retina, and cataract.

Fig. 1 (Wadsworth). High-power magnification of section in Case 1 at region of ciliary body. (A) Marked hyperplasia of ciliary epithelium extending axialward (B).

Macroscopic. The globe was of normal size. The anterior chamber was very shallow and there was a complete detachment of the retina.

Microscopic. There is edema of the cornea with a loss of epithelium. A wide peripheral anterior synechia is present completely occluding the filtration angle. A well-formed glass membrane resembling Descemet's extends from the posterior

surface of the cornea onto the anterior surface of the iris. The iris substance shows perivascular round-cell infiltration and some plasma cells. Occlusion and seclusion of the pupil is present and a large fibrous plaque exists on the anterior surface of the cataractous lens. The lens contains calcium.

The muscle of the ciliary body shows some hyaline degeneration, and the ciliary processes have lost, somewhat, there delicate structure and contain a hyalin material. Round-cell infiltration is prominent around the larger vessels. The epithelium of the ciliary body is thickened and reduplicated in places. Numerous vacuoles resembling fat deposits are seen in the nonpigmented layer.

In the region of the pars plana (fig. 1) there is a breaking up of the pigment epithelium with some proliferation. Extending axially from this area is a proliferation of the nonpigmented epithelium. These cells extend centrally and are arranged in sheets and irregular scallops. The central portion of the mass resembles a fibrous core but contains no vessels. In some areas of the proliferation there is marked vacuolation with a pink homogeneous material beneath. No necrosis or active inflammatory response can be found in the tumor.

Enmeshed amongst the zonules are small spheres of large epithelial cells arranged in various forms. These masses have no visible connection with the ciliary body, but are probably cross sections of similar processes described above.

The cells comprising the mass are large, typical epithelial cells with small oval nuclei and moderately clear cytoplasm. No abnormal or immature cells are seen.

This is a good example of hyperplasia of the ciliary epithelium.

B. Benign epithelioma

This tumor may be described as a well-circumscribed cell mass composed of nonpigmented cells encapsulated by a single layer of pigmented cells. These tumors are found by chance in the globes enucleated for various reasons but the high percentage is found among those eyes excised for glaucoma and neoplasms. Nearly all of these growths are seen in patients over 50 or 60 years of age. They are rarely over one millimeter in diameter and have apparently caused no symptoms because of their presence.

The tumor proper is composed of large oval epithelial-like cells with oval nuclei. The outer layer is arranged perpendicularly to the surface and the nucleus is near the base of the cells. This arrangement gives a sort of palisade along the outer portion of the tumor. The central portion is composed of cellular strands of 1 to 2 layers thick arranged perpendicularly to their long axis. Occasionally one sees an arrangement resembling rosettes. In such a case the polarity of the cells is still present with the nuclei in the outer circumference. The central portion is usually empty or may contain a pink-staining material. The central region of the tumor may show atrophic cells and vacuolization but no necrosis. No vessels or connective tissue are seen in these small tumors.

No true capsule is formed, but the outer surface is lined with pigment epithelium and not infrequently these cells become atrophic and lose their pigment—even disappear in places. On the inner surface of the ciliary body there is always a break in the pigment epithelium and this is the origin of the tumor. This could be called the hilum.

Case 2

History. A 67-year-old married woman with a basal-cell carcinoma of the lid had been given a large but unknown quantity of X ray and radium during the month prior to admission. The eye became injected and painful and an enucleation was done at the time of extensive resection of the lids.

Macroscopic. The globe is of normal size and grossly shows no abnormalities.

Microscopic. There is a complete loss of the corneal epithelium. Bowman's membrane is intact except peripherally where there is marked invasion of new vessels and connective tissue completely replacing the membrane. There is also an invasion of vessels into the stroma peripherally. Descemet's membrane and the endothelial layer appear normal.

The iris shows some hyalinization of the sphincter muscle and generalized atrophy of the stroma with a cellular condensation on the anterior surface. These cells appear to be a proliferation of the endothelial cells.

There is proliferation of the nonpigmented epithelial cells which fill up the recesses of the processes of the ciliary body (fig. 2-a). Embedded in the ciliary processes is a circumscribed collection of epithelial cells arranged in irregular scallops along the outer margin. The central area (fig. 2-b) is made up of irregular strands and numerous spaces of pink-staining material. No necrosis is seen. The tumor contains no true capsule but is surrounded by a layer of pigment epithelium. Numerous areas of atrophy can be seen. A well-marked hilum is demonstrated.

The lens shows proliferation of the anterior

Fig. 2-a (Wadsworth). Benign epithelioma in region of ciliary body demonstrating the proliferation of the nonpigmented epithelium. The tumor shows the typical scalloped arrangement of the epithelial cells (B). (A) points to the hilum.

subcapsular epithelium with some vacuolization and liquefaction of the anterior cortical region. Deep in the cortical region are islands of embedded subcapsular epithelial cells. In the posterior subcapsular region there is also liquefaction, all of which is typical of cataractous changes secondary to radiation (Reese[14]).

There is marked thickening of the lamina vitrea and these areas contain fine granules of calcium.

This is a good example of a benign epithelioma of the ciliary body.

Fig. 2-b (Wadsworth). High-power view of area indicated by square in Figure 2-a, showing the hilum, scalloped arrangement of epithelial cells and the lack of connective-tissue stroma.

II. Malignant tumors

A. Embryonic type or dictyoma

This has been called primary carcinoma by Lagrange.[15] It is seen in children between the ages of 1 and 8 years but there are two cases in the literature, one aged 16 years (Böck[16]) and one aged 28 years (Soudakoff[17]), with ciliary body tumors which meet all the criteria for their classification as an embryonic type of tumor.

Fig. 3-a (Wadsworth). Photomicrograph of section from the A. B. Reese collection, showing the malignant nature of the embryonic-type tumor of ciliary body. The tumor has eroded the sclera at the limbus and has extended outside the globe (A). This case was reported by Böck.[16]

In these tumors there is a questionable inflammatory background. Most observers do not consider inflammation statistically important in these cases.

The structure (fig. 3-a) consists of cell membranes of cylindric epithelial cells with

nuclei arranged in two or more rows with their axis vertically. There may be solid masses of cells like those seen in retinoblastoma and there may be rosettes (fig. 3-b). Invasive nature is a prominent feature and the iris, cornea, and sclera are often affected. The free surface may possess a limiting membrane not unlike the internal limiting membrane of the retina. Tubes, bands, and cavities are common to all tumors of this type.

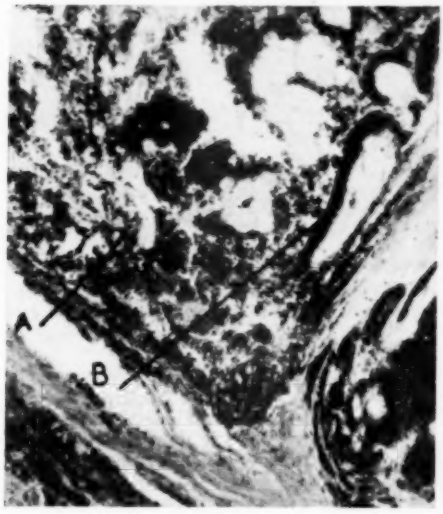

Fig. 3-b (Wadsworth). A high-power view taken at the area indicated by square in Figure 3-a, showing the cell formation. Rosettes (A) and cords (B).

Case 3

The slide was graciously loaned to me by Dr. A. B. Reese. A 16-year-old girl, who had been blind for about eight months, showed clinically a staphyloma at the limbus nasally. The globe was stony hard. Vision was light perception. This case was described by Böck.[16]

B. ADULT TYPE OF MALIGNANT TUMOR

This is seen in patients between the ages of 19 and 73 years, but the great majority of these patients are seen between the ages of 50 and 65. Of the cases reported in the literature some stress was laid on those cases which gave a history of inflammation or injury. Fuchs[4] reported a case of old septic endophthalmitis with bone formation which demonstrated an epithelioma of the ciliary body that infiltrated into and even destroyed the bone. The majority of the cases have a history of gradual decrease of vision with occasional episodes of pain. Clinically, lenticular opacities associated with appearance of a mass in the region of the angle are the most common signs. Less than half of the cases reported showed elevation of tension.

Case 4

Dr. J. H. Dunnington was kind enough to permit me to include this case in my series.

History. The patient, a 63-year-old man, gave a history of failing vision of the left eye for 3 to 4 years. There was no history of injury or inflammation; no history of pain or tenderness in either eye.

Examination. Vision was: L.E., 20/70; R.E., 20/20. Tension was normal in both eyes. The cornea of the left eye was clear with normal luster. The anterior chamber was of normal depth except in the region between the 12:30- and 3-o'clock positions where the iris was pushed forward. At about the 2-o'clock position the iris was cystic and there was a small pigmented area, 1.5 by 2 mm., in the peripheral region of the iris near the angle. Upon dilatation of the pupil, the lens showed cataractous changes which were dense in the upper nasal region. The lens was displaced backward.

Gonioscopically (fig. 4), the iris was pushed forward obliterating the angle in the region of the 12- and 3-o'clock positions. On the anterior surface of the iris was a heavily pigmented area beginning in about the middle of the iris and extending toward the angle. The pupillary region appeared atrophic in the upper nasal sector. Behind the iris a round heavily pigmented mass was pushing the iris forward and at the same time was displacing the lens backward where the tumor was in contact with the lens and the cataractous changes were most dense.

Because of the clinical appearance of the tumor, a diagnosis of malignant melanoma of the ciliary body and iris was made and the left eye was removed.

Macroscopic. On section of the globe an oval-shaped tumor of the ciliary body and base of the iris was seen. The tumor was covered with heavy pigment and was in contact with the lens pushing it backward. The mass measured about 3 by 3 mm.

Microscopic (fig. 4-a). A section of the cornea has been removed for keratoplasty. The remainder of the cornea is normal except for a region near the limbus which is the area of the tumor.

In the upper temporal aspect of the ciliary body

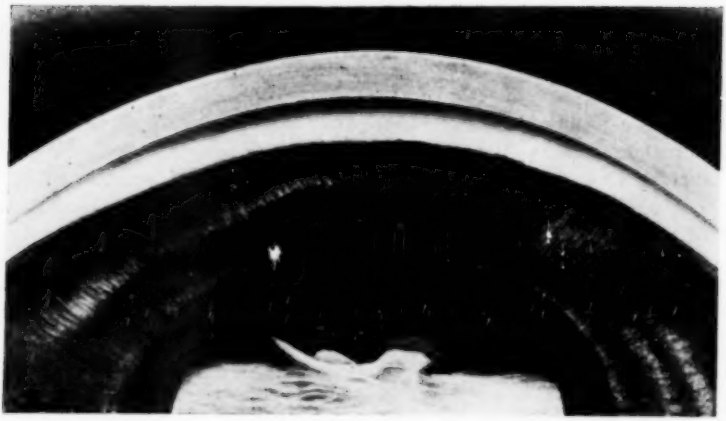

Fig. 4 (Wadsworth). The gonioscopic picture shown by Case 4. The tumor is pushing the iris forward and is in contact with the lens posteriorly. The dark area on the anterior surface of the iris is the extension of the tumor.

there is an oval-shaped tumor mass measuring 3.5 by 4 mm. The neoplasm appears to have arisen from the base of the ciliary body and pushed the ciliary processes backward. The tumor is fairly well circumscribed except near the base of the iris where it has destroyed this tissue and infiltrated into the corneal lamellae, meshwork of the iris, and ciliary body proper. Sheets of cells are seen on the anterior surface of the iris. These cells are large epithelial-like cells arranged in a sheet.

The cells of the tumor proper are for the most part nonpigmented epithelial-like cells arranged in sheets, cords, and folds that resemble tubules. There are many areas which show atrophy and cystic degeneration but no necrosis. The many spaces are filled with a pink-staining material. In these areas the cells are flattened and lose their distinct cell outline.

Fig. 4-a (Wadsworth). A low-power photomicrograph, showing the tumor in the region of the ciliary body.

Where the tumor (fig. 4-b) involves the base of the iris the cells become heavily pigmented. Otherwise pigment is sparse. However, where the growth has engulfed the ciliary processes the collections of pigment remain.

At the angle (fig. 4-c) the iris is completely replaced by tumor and these cells fill the angle as well as the meshwork. The adjacent tissue shows local infiltration but the cells are well differentiated and maintain their polarity, all of which is indicative of a relatively slow-growing tumor.

Very few new vessels are seen in the tumor and true connective-tissue stroma is lacking.

The infiltrative characteristic, as well as the destruction of the iris, suggests that this tumor has malignant potentialities—certainly it is locally malignant.

This tumor is a primary epithelioma of the adult type.

Butler and others[18] also described a tumor not unlike the above case which also showed extension onto the anterior surface of the iris. This was seen clinically as a tongue-shaped area of pigmentation on the anterior surface extending toward the pupillary area. The case reported by Keyes and Moore[19] showed a replacement of the iris in the region of the tumor and the lens capsule was ruptured and tumor tissue had infiltrated into the cortex of the lens.

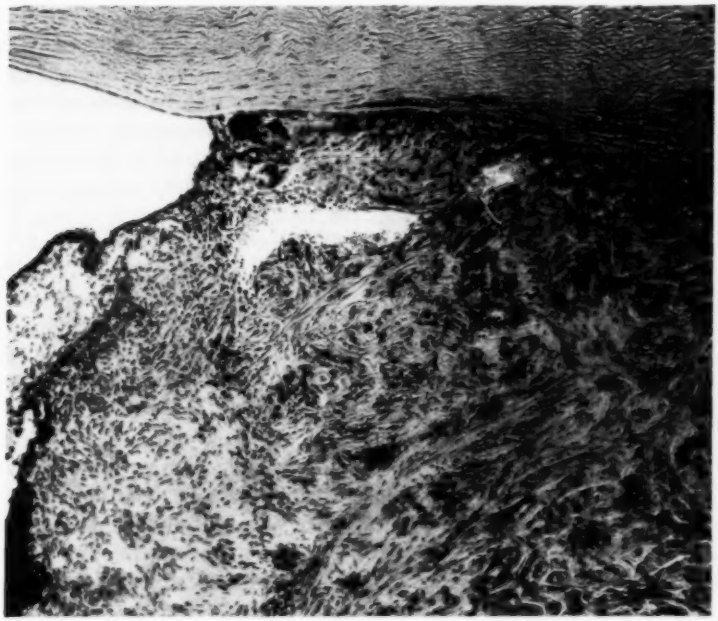

Fig. 4-b (Wadsworth). A high-power view of a section of the tumor taken from the area indicated by the square in Figure 4-a. It shows infiltration of tumor into stroma of cornea. The cells are arranged in cords and bands with very little connective-tissue stroma. Cells at the base of the iris contain pigment.

One of our patients (Case 5)* was younger than usual, being in his 20th year. Clinical signs of cataract were the first symptoms noted two years previously and showed persistent progress. Next, the iris became atrophic and pushed forward into the anterior chamber. At this time dilatation of the pupil revealed the tumor to be in the region of the ciliary body. The tumor (fig. 5) in this case eroded the capsule of the lens by its axial growth. This direction of growth is responsible for the early symptoms before more destruction of the iris and ciliary body could take place. The histology is identical with the previously discussed case.

Discussion

A true picture of the reported cases is a difficult problem because so few of the benign tumors have been recorded as an individual case. For the most part, the

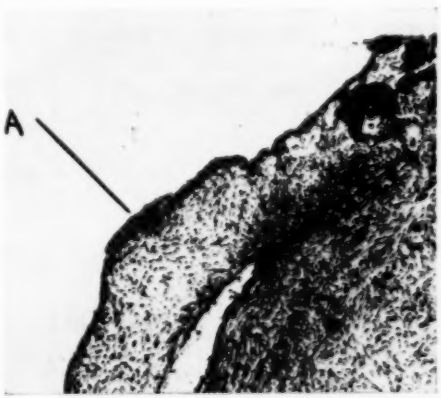

Fig. 4-c (Wadsworth). Section at a different level, showing the infiltration of the iris and the implant of tumor on the iris (A) as was seen clinically in Figure 4.

* See page 1497 for description.

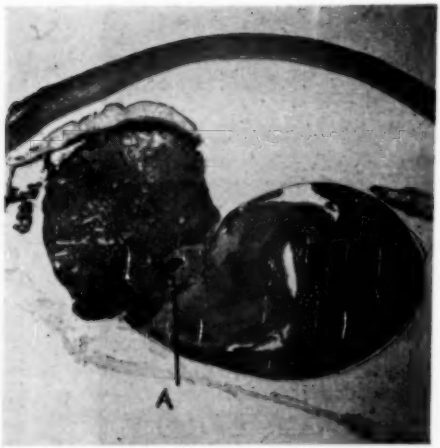

Fig. 5 (Wadsworth). Case 5. This shows the tumor encroaching on the lens with subsequent cataractous changes. At (A) the capsule of the lens is ruptured.

smaller tumors were described in passing while the eye was being reported for some unrelated condition.

Fifty-eight cases of epithelial tumors have been reported in the literature[1-8, 10-12, 17-21] and of these a high percentage have scanty descriptions with insufficient information to classify them accurately. However, Figure 6 is a simple table which gives some comparative data of the three types of tumors. As can be seen, the benign epithelioma (adenoma) was found in older patients but none was seen clinically. The apparently high percentage of inflammation is interesting but not significant since 41 percent of 1,938 consecutive eyes enucleated at the Institute of Ophthalmology, New York, either showed pathologic evidence, or gave a definite history, of inflammation. These large adult epitheliomas showed a very low incidence of inflammation. The statistics on the embryonic type is of no significance since more than half of the cases gave no history at all.

Levy-Wolfe[21] subdivided these small tumors into three classes according to the location in the ciliary body (fig. 7):

TYPE & NUMBER		AV. AGE	AV. SIZE	PREVIOUS INFLAMMATION
CASES FROM LITERATURE				
BENIGN	32	58	1.0 mm.	YES - 66% NO - 12 " ?-22%
MALIGNANT (adult)	10	34	3.8 mm.	YES - 16% NO - 84 "
MALIGNANT (embryonic)	16	11	2 mm. to full globe	NO - 43% ? - 57 "
THE AUTHOR'S CASES				
BENIGN EPITHELIOMA	10	61	0.48 mm.	YES - 20% NO - 80 "
MALIGNANT EPITHELIOMA (adult)	9	56	2.8 mm.	NO - 43% ? - 57 "

Fig. 6 (Wadsworth). Comparative data of the types of epithelial tumors reported in the literature and herein reported.

Class I. The pedunculated type on the surface of the ciliary body.

Class II. Countersunk in the substance of the process.

Class III. Completely embedded in the process.

Fig. 7 (Wadsworth). A diagrammatic representation of the three classes of ciliary-body tumors as described by Levy-Wolfe.

Such a classification is an unnatural one and is of no real importance. By study of serial sections a single tumor may fit into more than one classification depending on the level at which the tumor was sectioned.

The first section of our Case 6* (fig. 8-a) shows a small tumor in the substance of the ciliary body which would place the growth in Class III. Another section (fig. 8-b) of the same tumor shows an entirely different location and this time the tumor would be placed in Class I.

Fig. 8-b (Wadsworth). The same tumor as shown in Figure 8-a but at a different level and classified, according to Levy-Wolfe, as Class 1.

These so-called benign adenomas may continue to grow and extend beyond the confines of the pigment epithelium and into the substance of the ciliary body proper (fig. 9). As the cells extend into the stroma of the

Fig. 8-a (Wadsworth). Case 6. This shows the tumor in the substance of the ciliary body and classified, according to Levy-Wolfe, as Class 3.

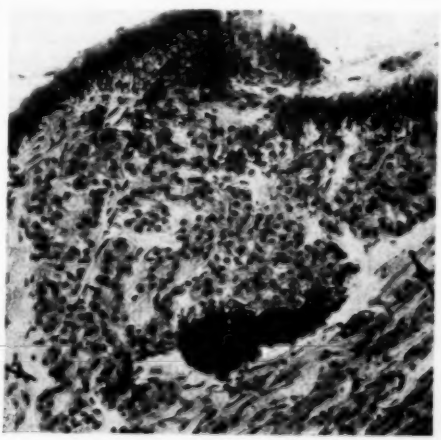

Fig. 9 (Wadsworth). A small epithelial tumor with cells extending outside the confines of the pigment capsule indicating early malignancy with local extension.

* See page 1497 for description.

ciliary body, they become larger and more nearly spherical in shape, and they often form small acini. This growth certainly indicates local malignancy.

The formation of these tumors has aroused sufficient interest to cause some writers to speculate on the manner in which they develop. It is generally agreed that proliferation of the nonpigmented epithelium is the most active process; however, the pigmented epithelium must play a part. All cases of the so-called benign epitheliomas or adenomas are partially, if not completely, surrounded by the pigmented epithelium. There is always a small break in the pigment epithelium through which the nonpigmented cells grow (fig. 10-a, b, c, d).

Preceded by the invagination of the nonpigmented cells, there is an invagination of the pigmented cells forming a potential cavity into which the nonpigmented cells can grow. If the nonpigmented cells do not keep pace with the pigmented cells, a cyst may be formed.

From the above process there is a hilum formed and a pedunculated tumor in reverse is the result.

In conclusion I believe it is obvious that these small so-called benign epitheliomas may grow and show malignant characteristics as manifested by the destruction of tissue and infiltration. Extension outside the globe in the adult tumors has not been seen because alarming symptoms arise early in the

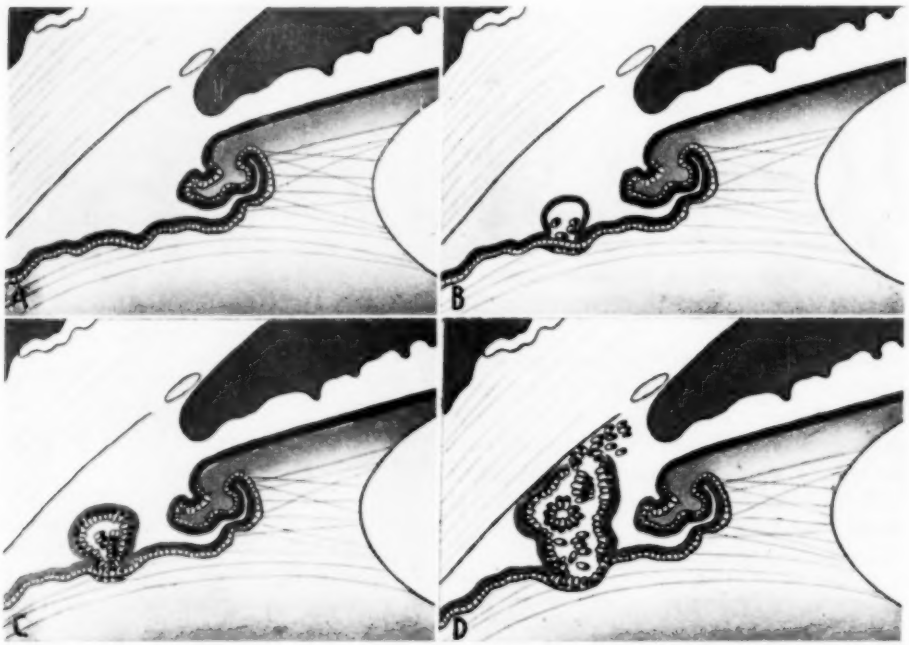

Fig. 10 (Wadsworth). (A) A diagrammatic picture of a normal ciliary body. (B) The beginning formation of a small epithelial tumor, showing the invagination of the pigment epithelium with a proliferation of the nonpigmented epithelium. (C) A further development of the tumor in (B), showing the palisade arrangement of the epithelial cells along the pigmented portion. (D) The progress of the tumor is shown by the rupture of the pigmented layer and the infiltration of the cells into the substance of the ciliary body proper.

disease and the eyes are usually removed.

The embryonic type is far more malignant and has the characteristics of a retinoblastoma.

Report of cases*

In the pathology department of the Institute of Ophthalmology there are 20 cases of primary epithelial tumors of the ciliary body (fig. 6).

Case 5

Graciously loaned to me by Dr. W. T. Boland.

History. A 20-year-old white man had worn glasses for the past 12 years. His refraction has been checked at regular intervals. Two years ago the lens of the left eye showed some cataractous changes but one year later he passed an army test for vision but, after another year, the vision of the left eye was 20/100, not improvable.

The lens was markedly cataractous with the greatest opacification in the nasal half. The iris was pushed anteriorly against the posterior surface of the cornea on the nasal side by a growth in the region of the ciliary body. The iris in this region was atrophic.

Upon dilatation of the pupil, the edge of the growth could be seen. It had a brownish color and was in contact with the lens. The angle was completely blocked nasally. The fundus was poorly seen because of the lens changes. The tension was normal. No family history of malignancy could be elicited.

The macroscopic picture showed a well-circumscribed, brownish mass in the ciliary body nasally. The iris was pushed forward in this region and the lens was pushed temporally and posteriorly. The remainder of the eye was normal.

The microscopic picture reveals the cornea to be normal. Nasally the iris is pushed forward by a round cellular mass originating from the base of the ciliary body. There is a wide posterior synechia over this area with some proliferation of pigment cells of the iris. The tumor mass extends axialward to compress and displace the lens temporally. The nasal portion of the lens is cataractous with some calcium deposits in the lens cortex. The tumor has eroded the capsule of the lens.

The tumor is made up of large epithelial cells with pink cytoplasm and round or oval, lightly stained nuclei. The cells are arranged in cords, bands, and occasional acini. Some areas show atrophic changes characterized by pale, indistinct cell outlines with some cystic degeneration. No necrosis is present. Very few vessels are seen and there is no evidence of inflammation. The greater part of the tumor is surrounded by pigment epithelial cells, but none of the tumor contains pigment and there is very little supporting tissue seen.

The remainder of the ciliary body is normal except for some edema in the region of the tumor. The retina and choroid are normal and there is no evidence of inflammation.

Histologically this tumor is identical with those small "benign" epitheliomas, but this has grown large enough to have been seen clinically and has injured the lens.

Case 6

The patient was a 50-year-old man who had a marked exophthalmos and optic atrophy.

Microscopic. The corneal epithelium shows keratinization. The remainder of the cornea, anterior chamber, and iris are normal. Embedded in the ciliary processes is a well-circumscribed epithelial tumor measuring 0.3 mm. in diameter. One section shows the tumor completely surrounded by the ciliary process; whereas, at another level the small tumor is on the surface of the ciliary body. The basal cells of the tumor are perpendicular to the surface and the center of the tumor is made up of strands of cells arranged perpendicular to the long axis of the strand. Usually these strands are two cells thick. Between these bands is a pink-staining material. This is an epithelioma of the adult type.

Case 7

The eye was removed from a middle-aged man because of a basal-cell carcinoma of the lid with extension to the conjunctiva.

Microscopic. Polymorphonuclear infiltration into the cornea with some extension of the basal-cell epithelioma at the limbus.

Near the base of the ciliary body there is a small, nonpigmented tumor measuring 0.3 by 0.4 mm. The pigment epithelium is invaginated and its continuity is broken at one place where the tumor cells are spreading outside the confines of the pigment epithelium.

The tumor is made up of the large epithelial cells arranged perpendicular to the outer surface. The cells in the center of the tumor are roughly ovoid and are arranged in bands and primitive acini. These central cells have variable shaped nuclei; some are round and others are spindle-shaped. No visible supporting tissue can be seen. The cells that have pushed their way outside the confines of the pigment epithelium into the substance of the ciliary body are more nearly round. This is an example of an epithelioma with local extension.

Case 8

History. A 26-year-old man with an intraocular foreign body of six weeks' duration showed chronic inflammation and finally hypopyon. The eye was enucleated for fear of sympathetic ophthalmia.

Microscopic. There is an oblique wound through

* Cases 1 to 4 have already been described.

the cornea nasally, 2 mm. from the limbus. Some sections show incarceration of the iris in the wound and an increase in vascularization of the cornea between the wound and the limbus. Many polymorphonuclear cells also infiltrate the iris stroma. There is a large laceration of the anterior and posterior capsule of the lens. There is, also, an abscess of the vitreous with a sprinkling of polymorphonuclear leukocytes along the surface of the internal limiting membrane. The choroid and retina are also affected with the same inflammatory process.

In the ciliary body near the base is an aggregation of nonpigmented epithelial cells. The pigment epithelium has become invaginated and forms what appears to be a capsule. Other sections show this to be incomplete and the cells are infiltrating (pushing) out into the substance of the ciliary body. The cells are arranged roughly in rosettes and sheets. The oval nuclei are perpendicular to the outer circumference of the rosettes and located peripherally. The center of these rosettes is filled with a pink-staining material. Several small capillaries are seen and a few scattered connective-tissue cells too. When the pigment epithelium is lacking and the nonpigmented cells are extending from the main mass, the cells are more nearly round and arranged in solid groups. This is an example of epithelioma of the adult type.

Case 9

History. A 77-year-old man had acute glaucoma following the use of atropine five years ago. An iridectomy was done shortly after. There was no history of inflammation.

Microscopic. The epithelium is separated from the cornea by a sheet of connective tissue in the area of the operative incision. Descemet's membrane is incarcerated in the stroma of the cornea. There is a wide peripheral anterior synechia. The ciliary body shows many of its processes to be calcified.

In the region of the base of the ciliary body there is a collection of epithelial cells arranged in whorls and bands with a central structureless pink-staining material. The pigment epithelium is indented and partially surrounds the nonpigmented cells. There is no invasion of tissue. This is a benign epithelioma.

Case 10

History. An 81-year-old man with absolute glaucoma had had a paracentesis two days prior to enucleation. No history of inflammation was present.

Microscopic. The iris is trophic and a membrane of fibrous tissue extends over the anterior surface of the iris.

In the atrophic ciliary body is a small area of proliferation of nonpigmented epithelial cells curled into sheets. The outer portion is lined with the typical large epithelial cell. Several small capillaries can be seen inside the tumor and vacuolization is a prominent feature. There is no infiltration. Impression—benign epithelioma.

Case 11

Long-standing chronic noncongestive glaucoma. Pneumococcal corneal ulcer two weeks prior to enucleation.

Microscopic. Loss of corneal epithelium with polymorphonuclear infiltration through the layers of the stroma with loss of substance. Anterior chamber contains large numbers of polymorphonuclear cells with posterior corneal abscess. Iris is infiltrated with polymorphonuclear leukocytes.

Near the region of the pars plana of the ciliary body there is a break in the pigment epithelium with invagination of the nonpigmented epithelium. These cells are arranged in sheets and acini. At one area the pigment epithelium is missing and the nonpigmented epithelium is growing free in the stroma of the ciliary body. This is evidence of local malignancy of a small epithelioma.

Case 12

History. A 79-year-old woman had a growth on the inner surface of the lid, bulbar conjunctiva, and cornea of the left eye. The corneal growth proved to be an epithelioma of Bowen's type.

Microscopic. There is a projection of the nonpigmented epithelium into the substance of the ciliary body. Between the cells is a pink-staining material. There is a break in the pigment epithelium.

The nonpigmented epithelial cells are arranged in sheets and cords with some scalloped arrangement. No newly formed vessels are seen. This is a benign epithelioma.

Case 13

History. Age unknown. Failing vision for one year. Irregularity of the pupil and a small elevated area of iris in the pupillary area at the 1-o'clock position. The elevated area increased in size under observation. Tension = 100 mm. Hg (Schiøtz). Enucleation was done because of a blind, painful eye with a suspected tumor of the iris.

Microscopic. The section has badly faded but cytology is possible. The cornea is normal except for irregularity of epithelium. The filtration angle is open but the meshwork of the angle shows thickening and sclerosis of the trabeculas. The iris is thickened in the pupillary region by an infiltration of a spindle-cell tumor which appears to arise from the sphincter. The lens is normal.

In the region of the sims in the ciliary body there is a well-circumscribed tumor, measuring 0.5 by 0.5 mm., composed of large epithelial cells originating from the nonpigmented epithelial cells of the ciliary body. The tumor is partially surrounded by the pigmented cells except in the region of the hilum.

The outer portion of the tumor is lined with the nonpigmented cells arranged perpendicular to the

surface and with nuclei toward the base of the cell. The central area contains many empty spaces. These areas are made up by the numerous bands and sheets of cells forming a coarse network. These bands are two-cells thick arranged perpendicular to the long axis of the bands. No newly formed vessels or connective tissue are seen in the substance of the tumor. No evidence of inflammation is present. Impression—(1) Leiomyoma of iris; (2) benign epithelioma of the ciliary body.

Case 14

History. A 56-year-old woman had had failing vision in the right eye for over one year. There was no pain or inflammation. Physical examination revealed a large detachment of the retina with questionable transillumination. The pigmentation was extremely heavy throughout the eye.

Microscopic. The entire uveal tract is thicker than usual, especially on the temporal side where it is four times its normal thickness and the chromatophores are engorged with pigment.

In the ciliary body near the base is an aggregation of nonpigmented epithelial cells almost completely surrounded by pigment epithelial cells. The outer cells are arranged perpendicularly to the outer margin of the tumor and the nuclei are near the base. The inner portion is made up of irregular bands or sheets and poorly formed acini. No connective tissue or newly formed vessels can be seen in the tumor.

Diagnosis. Melanosis oculi and benign epithelioma of the ciliary body.

Case 15

A 35-year-old woman who had had failing vision for one month presented no history of injury or inflammation.

Microscopic. Arising in the choroid in the lower temporal portion of the globe is a pigmented tumor which has pushed the ciliary body axialward and forward. The tumor has produced a detachment of the retina and the tumor of the choroid is made up of cords of epithelial cells containing pigment. The outermost part of the tumor contains pigment but the central portion shows areas of necrosis and hemorrhage.

In the region of the sims there is a small, circumscribed, nonpigmented tumor composed of epithelial cells resembling those of the nonpigmented cells of the ciliary body. The tumor is almost completely surrounded by pigmented epithelial cells. There is a single layer of nonpigmented cells along the outer surface arranged perpendicularly to the surface and their nuclei are near the base of the cells. The tumor proper is made up of irregular acini and scallops with many spaces. These spaces are filled with a pink-staining, homogeneous material.

Diagnosis. Malignant melanoma of the choroid and benign epithelioma of the ciliary body.

Case 16

No history is available.

Microscopic. The cornea shows some irregularity of the epithelium with some evidence of cornification. In the central region of the cornea Descemet's membrane is irregular and absent in places. In these areas there is proliferation of the endothelium with deposits of pink-staining material. The anterior chamber is of normal depth.

Along the anterior surface of the iris is a sheet of large epithelial cells varying from one cell to 6 or 7 cells thick. These cells are arranged in solid sheets and some have the appearance of columnar cells. One mitotic figure is seen. Numerous empty spaces are seen in the tumor. These cells also course along the inner surface of the cornea and across the angle and completely occlude it. There is occlusion and seclusion of the pupil by extension of the tumor.

In the region of the base of the ciliary body and the base of the iris there is an accumulation of large, nonpigmented epithelial cells arranged in sheets and poorly formed acini. These cells extend into the ciliary body proper and onto the surface of the iris.

The remainder of the eye is not remarkable. There is no evidence of inflammation.

Diagnosis. Malignant epithelioma of the ciliary body; glaucoma, secondary to tumor.

Case 17

No history is available.

Microscopic. The eye has been subjected to a severe inflammation which has subsided with the result of extensive bone formation which almost completely fills the interior of the globe. Many of the internal structures are not identifiable.

In the region of the ciliary body is a mass of epithelial cells arranged in irregular tubes and folds. The outermost group of these cells contain pigment. The central portion of the tumor is atrophic and the cells are arranged in cords and bands. The adjacent bone has been eroded by the neoplasm.

Diagnosis. Malignant epithelioma of the ciliary body in an old phthisical eye.

Case 18

No history is available.

Microscopic. In the region of the ciliary body and the iris there is an epithelial growth extending into the anterior chamber and destroying the immediate portion of the iris. The tumor cells have infiltrated into the inner layers of the sclera near the scleral spur.

The original portion of the tumor is typical in its formation but, as the tumor has extended and gained momentum, numerous bands and membranes can be seen associated with many empty spaces. In the region of the iris the cells contain pigment but elsewhere the tumor is free of pigment.

Diagnosis. Malignant epithelioma of the ciliary body.

Case 19

History. A 77-year-old woman with senile cataracts had had no history of inflammation. The tension was normal. An intracapsular extraction of the left eye was followed by detachment of the choroid and softening of the eye. Six weeks later the tension rose to 70 mm. Hg (Schiøtz) and treatment failed to relieve the pain. The eye was subsequently removed.

Microscopic. The cornea showed some vascularization of the deep layers of the stroma and in the anterior chamber and on the anterior surface of the iris there are two large cystlike areas made up of epithelial cells. The retina is detached and there is marked thickening of the lamina vitrea and proliferation of the pigment epithelium of the retina.

In the ciliary body there is an accumulation of nonpigmented epithelial cells which forms a well-circumscribed tumor. The mass is surrounded by pigmented epithelial cells. Cellular arrangement is typical with the benign epithelioma.

Diagnosis. Epithelization of the anterior chamber; glaucoma secondary to epithelization of the anterior chamber; benign epithelioma of the ciliary body.

Case 20

History. The patient was struck in the right eye 22 years previously and there was no light perception following the injury. The eye was blind and shortly before enucleation the eye became injected and painful.

Microscopic. The globe is somewhat deformed. The cornea is irregular in thickness and irregularity of Descemet's membrane is seen at one place. There is sclerosis of the pectinate ligament with occlusion of Schlemm's canal. Atrophy of the iris with edema is well marked and edema extends to the ciliary body.

In one of the ciliary processes near the base is a cellular collection of nonpigmented epithelial cells which is partially encapsulated by pigment epithelial cells. Near the base of the tumor the pigmented epithelial cells are not present and a well-formed hilum can be seen. The cells in the outer portion of the tumor are perpendicular to their base and the nuclei are in the outer portion of the cells. The central portion is made up of irregularly arranged cells but there is a tendency to form acini, the lumina of which contain a pink material.

Diagnosis. Benign epithelioma of the ciliary body.

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Ophthalmic Miniature

Egyptian Ophthalmology

In Egyptian writing, the corneal ulcer was symbolized by the crocodile. The Greeks, who did not know the crocodile from first-hand experience, used the crab as a symbol for a painful disease, and corneal ulcer was cancer to them.

Hirschberg, *Graefe-Saemisch Handbuch.*

RETROBULBAR ALCOHOL INJECTIONS*

Relief of ocular pain in eyes with and without vision

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The treatment of prolonged severe ocular pain is one of the most trying problems in ophthalmology. Frequently partially seeing eyes and blind eyes which are not disfiguring or otherwise dangerous are removed because the patients can no longer tolerate the pain caused by them. In many instances these patients can be relieved of pain for several months or longer by the use of retrobulbar alcohol injections. If during this interval the cause of the pain is alleviated, the eyes might be saved and in some instances useful vision retained. Retrobulbar alcohol injections should, therefore, have a very definite place in the armamentarium of ophthalmic therapy.

For many years encouraging reports on this procedure have appeared in the German and French literature but its use has not been so well accepted in this country. In the few reports which have appeared in the English literature the possibility of complications in the form of extraocular palsies and injury to the optic nerve have been stressed. It is the purpose of this communication to report the use of retrobulbar alcohol injections for ocular pain in 41 blind eyes and 15 eyes with partial vision. These injections were given by members of the staff of the Wilmer Institute of Ophthalmology between the years of 1942 and 1948.

Grüter[1a] published the first report on the use of retrobulbar alcohol injections in 1918. In 1943[1b] he reviewed the literature and summarized his experiences of 25 years with this therapy. He advocated the use of 1 to 3 cc. of 80- to 90-percent ethyl alcohol without previous injection of novocain in blind painful eyes as an alternative for enucleation. The transient complications of chemosis of the conjunctiva, slight proptosis of the globe, and extraocular palsies which follow alcohol injections were described in some detail. Only a few patients who received an injection of 3 cc. of 80- to 90-percent alcohol developed a permanent paralysis of the ocular muscles. In Grüter's 25 years of experience with this therapy he observed only one case of neuroparalytic keratitis after an injection of 3 cc. of 70-percent alcohol. The complications of herpetic keratitis and corneal ulcer, which not infrequently follow injections of the Gasserian ganglion, were not encountered in his cases.

In 1930 Weekers[2a] reported the use of 40-percent alcohol injections for the relief of pain in patients with seeing eyes who had corneal ulcers, keratitis, uveitis, and primary congestive glaucoma. He injected 1 cc. of novocain, removed the syringe from the needle and, after five minutes, injected 1 cc. of 40-percent alcohol. He again reported the use of this procedure in 1939[2b] and 1941[2c] and stated that he had occasionally observed a temporary paralysis of one or more of the extraocular muscles but had not observed any permanent complications. Damage to the optic nerve was not noted from this procedure. In some cases of primary glaucoma, the ocular tension was reduced for a few days to a week following the injection. He suggested that this therapy be used to lower the ocular tension so that an interval operation might be performed. Weekers thought that alcohol injections had a curative effect in some cases of anterior uveitis and interstitial keratitis.

Magitot[3] has also advocated retrobulbar injections of 1 cc. of 40- to 50-percent alcohol for painful inflammations of the anterior segment of the eye (such as interstitial keratitis, gonococcal iritis, and phlyctenular ker-

* From the Wilmer Ophthalmological Institute of The Johns Hopkins Hospital and University. Presented before the Section of Ophthalmology, American College of Surgeons, October, 1948.

atitis) and for acute congestive glaucoma. He stated that he had never seen a permanent extraocular palsy or injury of the optic nerve from this procedure.

There are only a few references to the use of retrobulbar injections of alcohol in the English literature. Fejer[4] in 1932 reported its use in five cases. Gifford[5] in his book on ocular therapeutics mentioned its value for the relief of pain. Hartman[6] in 1942 referred to the work of Grüter, Weekers, and Magitot. Goulden[7] in 1943 reported that he had found 1 cc. injections of 40- to 60-percent alcohol to be of value in cases of interstitial keratitis, uveitis, and subacute glaucoma, but he did not record how many times he had used this procedure. In the discussion of Goulden's communication, Goldsmith mentioned that he had observed a sterile abscess following the use of an 80-percent alcohol injection in one patient. This complication must be extremely rare for it is not mentioned in the reports of Grüter, Weekers, or Magitot.

The only instance of injury to optic nerve recorded in the literature is the report of Cordes[8] in 1929. In this patient, the optic nerve was injected when an attempt was made to inject the sphenopalatine ganglion. The patient saw a sudden flash of light during the injection, and suffered a permanent total loss of vision. He also developed paralyses of the extraocular muscles and ptosis. The optic nerve became atrophic but the motor function of the muscles returned.

Method of injection and reaction

The technique for retrobulbar alcohol injections in the series of patients reported here has been similar to that described by Grüter, Weekers, and Magitot. The patient is requested to look up and nasally and a 3.5-cm., 22-gauge needle is inserted into the lateral third of the lower lid just above the rim of the orbit. The needle is then passed through Tenon's capsule between the external and inferior rectus muscles into the muscle cone. An effort is made to keep the needle as close to the back of the globe as possible. The plunger of the syringe is withdrawn slightly to be sure the needle has not entered a blood vessel. One cc. of 2-percent novocain is injected into the muscle cone. The syringe is removed leaving the needle in place. After 3 to 5 minutes, the corneal sensitivity and extraocular muscles are tested to be sure the needle is in the proper position. A syringe containing 1 cc. of ethyl alcohol is attached to the needle and the solution injected into the orbit. The patients frequently complain of a sharp pain in the orbit or a dull occipital headache for a minute or two after the injection. Care should be taken not to make the injection into one of the extraocular muscles or too near the levator muscle. If the injection is given close to the posterior part of the globe and not deep in the muscle cone, fewer muscle palsies occur.

About one hour after the injection chemosis of the conjunctiva and proptosis of the globe develop. This reaction lasts from two days to a week. A partial paralysis of one or more of the extraocular muscles or a ptosis occurs in about 50 to 75 percent of the patients. This complication lasts for a few days to two months depending on the site of the injection. In no instance in this series has a permanent paralysis occurred. Neither neuroparalytic nor dendritic keratitis has occurred in a single case after injection. The patients frequently complain of a feeling of fullness of the orbit for 24 to 48 hours after injection but when the injection has been given properly the ocular pain is relieved. If the injection has not been given correctly and the patient's symptoms are not relieved, the injection can be repeated without danger 2 or 3 days later.

When alcohol therapy was first used at the Wilmer Institute, we were apprehensive about the reactions which might follow, so only 1 cc. of 40- to 50-percent ethyl alcohol was used after an injection of 1 cc. of 2-percent novocain. Pain was not always controlled with this strength solution and the complica-

TABLE 1

RETROBULBAR ALCOHOL INJECTIONS IN BLIND EYES
(Less than 10/200 vision)

Diagnosis	No. of Cases	Diagnosis	No. of Cases
Absolute glaucoma	22	Phthisis bulbi	2
Secondary glaucoma	6	Keratitis after mustard gas burn	1
Parenchymatous keratitis and uveitis	6	Keratoplasty	1
Corneal ulcer	2	Endothelial dystrophy	1

tions were not severe or permanent so 95-percent ethyl alcohol was tried. The results have been more consistent with the stronger solution and the reactions only slightly greater. Therefore during the past four years only 80- to 95-percent alcohol has been used. The blind eyes in which 40- to 50-percent alcohol was given are not included in this report.

ALCOHOL INJECTIONS ON BLIND EYES

A retrobulbar injection of 1 cc. of 95-percent ethyl alcohol was done on 41 eyes with less than 10/200 vision. Many of these eyes would have been enucleated because of pain. A tabulation of the diagnoses in these eyes is given in Table 1. In six patients the pain was not alleviated either because the injection was not given properly or because not enough alcohol was used. Pain was controlled in 35 eyes for at least one month. Eleven of the patients were not seen in the clinic after one month so it is not known whether the pain returned after this time or not. In seven patients the pain returned after two months or longer and the eyes were removed. The remaining 17 patients were followed for two months to three years. In these patients the pain did not return or it returned only intermittently and was not severe enough for the patient to desire enucleation.

Fifteen eyes were removed after alcohol injections affording an opportunity for studying histologically the effect of alcohol injections on the optic nerve. In 13 of these eyes the pain was either not controlled or returned several months after the injection.

TABLE 2

FIFTEEN EYES EXAMINED HISTOLOGICALLY AFTER ALCOHOL INJECTION

Diagnosis		Pain Controlled	Interval Between Injection and Enucleation	Optic Nerve
Absolute glaucoma	(4 eyes)	Not controlled	2 eyes—4 days 2 eyes—1 week	Glaucomatous optic atrophy but no abnormal cellular infiltration
Absolute glaucoma and corneal abscess	(1 eye)	Not controlled	2 weeks	
Absolute glaucoma	(3 eyes)	2 months	2 months	
Absolute glaucoma	(1 eye)	3 months	8 months	
Absolute glaucoma	(2 eyes)	4 months	5 months	
Phthisis bulbi	(1 eye)	Not controlled	1 week	Optic atrophy
Parenchymatous keratitis	(1 eye)	7 months	17 months	Normal nerve
Corneal ulcer	(2 eyes)	1 month	1 month	Normal nerve

In two instances the pain was controlled for one month but the eyes were removed because the patients were elderly; had severe corneal ulcers in one eye, and normal vision in the other eye. The time of removal of these eyes after alcohol injection is listed in Table 2. In the eyes with absolute glaucoma, there was advanced atrophy of the optic nerve but in no case was there a marked cellular infiltration of the nerve or nerve sheath to indicate that damage had been produced by the injection.

In a few eyes removed shortly after injection, there was a slight cellular infiltration of the posterior superficial sclera which might have been caused by irritation from the alcohol. The three eyes removed because of corneal ulcers and parenchymatous keratitis were extremely valuable for they showed no evidence of atrophy or injury of the nerves.

This group of cases indicates that the injection of 1 cc. of 2-percent novocain followed by 1 cc. of 95-percent alcohol will control ocular pain for 1 to 3 months if the injection is given properly. The anesthesia is not permanent, however, and if the primary cause of pain is not remedied the pain will return when the nerves regenerate. Histologic examinations of the optic nerves in 15 cases did not show evidence of injury by the alcohol.

Alcohol injections on eyes with partial vision

Retrobulbar alcohol injections have been done in 15 patients whose final visual acuity ranged between 10/200 and 20/20. The type of ocular lesion, duration of pain before alcohol injection, the amount of alcohol injected, and the visual acuity before and after injection are listed in Table 3. When alcohol injections were first used on eyes with partial vision, we feared that the optic nerves might be injured by this procedure. Therefore, in the first three patients only 1 cc. of 45-percent ethyl alcohol was used after an injection of 1 cc. of 2-percent novocain. Vision was not reduced following this treatment.

During the interval these patients were being followed, 95-percent alcohol was found to be much more effective in controlling pain in blind eyes and histologic examination of several eyes after injections of this strength alcohol failed to show evi-

TABLE 3

Retrobulbar alcohol injections in eyes with partial vision
(Final Vision 10/200 to 20/15)

Diagnosis	Duration of Pain	Amount of Alcohol	Vision at Time of Injection	Final Vision and Interval After Injection
Tuberculous keratitis	8 mo.	1 cc. 45%	1/200	20/50 6 yr.
Epidemic keratoconjunctivitis	3 mo.	1 cc. 45%	20/50	20/20 5 yr.
Epidemic keratoconjunctivitis	4 mo.	1 cc. 45%	20/40	20/20 1 yr.
Uveitis after cataract extraction	4 mo.	1 cc. 95%	10/200	20/100 2 mo.
Uveitis after cataract extraction	5 mo.	1 cc. 95%	20/50	20/15 2 yr.
Disciform keratitis	5 mo.	1 cc. 95%	20/70	20/40 5 mo.
Disciform keratitis	4 mo.	1 cc. 95%	20/30–2	20/20 1 yr.
Disciform keratitis	2 mo.	1 cc. 95%	20/100	20/25 8 mo.
Herpes zoster keratitis	9 days	1 cc. 95% after 2 days 1 cc. 95%	1/200	20/30 6 mo.
Herpes zoster keratitis	11 mo.	1 cc. 95%	4/200	20/100 5 mo.
Postoperative panophthalmitis	8 days	1 cc. 95%	L.P.	20/30 1 yr.
Recurrent corneal erosion	2 mo.	1 cc. 95%	20/200	20/100 9 mo.
Sympathetic ophthalmia in remaining eye	1 yr.	1 cc. 95%	L.P.	20/100 1 yr.
Glaucoma secondary to uveitis	14 days	1 cc. 95%	3/200	20/200 2 mo.
Glaucoma secondary to uveitis	3 mo.	1 cc. 95%	10/200	10/200 6 mo.

dence of injury to the optic nerves. We therefore began to use 95-percent alcohol in eyes with partial vision. Twelve eyes have been injected with the stronger solution of alcohol and in no instance has the visual acuity been reduced from this procedure.

Case reports

The results of alcohol injections in these eyes with vision have been so striking that several of the cases will be described briefly.

The first patient with a potentially seeing eye to be injected had a parenchymatous keratitis with marked photophobia and blepharospasm. The lesion was located primarily in the central portion of the cornea, the pupil would not dilate adequately with atropine, and his vision was reduced to hand motions at two feet. He had not been able to work for eight months because of his pain. An enucleation was considered because his keratitis did not respond to the usual forms of therapy and because of the protracted course of this illness. One cc. of 45-percent ethyl alcohol relieved his pain completely and his pupil became more dilated so that his vision improved to 20/70. It has now been six years since the injection. Vision is 20/70 with a full visual field. The patient has had several minor exacerbations of his keratitis during this interval but none of them have been severe enough to warrant a second alcohol injection.

A second patient had a persistent low-grade anterior uveitis following a cataract extraction. The uveitis failed to respond to antibiotics, typhoid-fever therapy, salicylates, and local atropine. He had been confined to his house and hospitalized for five months. His vision was 20/50 but he requested enucleation for the relief of his pain. A 1-cc., 95-percent alcohol injection completely relieved his pain. During the next three months his uveitis gradually subsided and his vitreous opacities cleared. It has now been two years since his alcohol injection and his vision is 20/15 with a full visual field.

A third patient had a disciform lesion following a dendritic keratitis of four months' duration. His vision was 20/30−2 but he was unable to work for several days each week because of photophobia and ocular pain. A 1-cc., 95-percent alcohol injection relieved his pain. This patient suffered a partial paralysis of the external rectus muscle which caused diplopia for two weeks. The eye was occluded during this interval and the patient was able to return to work. The edema of the cornea subsided during the next two months and the patient now has a small scar in the inferior portion of his cornea. It has been one year since the injection and his vision is 20/20 with a full visual field.

In a fourth patient with herpes zoster keratitis, the first injection of 1 cc. of 95-percent alcohol did not control the pain and a second injection was given two days later. He developed a marked orbital reaction and a paralysis of several of his extraocular muscles which lasted for a month. This patient's visual acuity six months after injection had improved from counting fingers at two feet to 20/30.

In most eyes in this series alcohol injections have had little effect on the basic inflammatory lesions. It has merely relieved the patient's pain while the lesions have undergone their natural process of healing. In four cases of keratitis, however, two which followed epidemic keratoconjunctivitis and two which followed herpetic keratitis, the course of the disease might have been shortened by alcohol injections. In these patients the epiphora and blepharospasm, which might well have been contributing to the continuance of the keratitis, were relieved by the alcohol injections.

In this series of cases injections have not been used to reduce the ocular tension in primary congestive glaucoma as advocated by Weekers and Magitot. It was used in two eyes with secondary glaucoma, however. In one eye the tension was lowered and in the other it was not affected.

In summary, retrobulbar alcohol injec-

tions have been done on 15 patients who have had severe or protracted ocular pain and partial vision. No permanent complications have followed the injections and in most cases the final visual acuity has been better than it was at the time of treatment.

Discussion

Retrobulbar alcohol injections are a valuable adjunct to ophthalmic therapy for the relief of severe protracted ocular pain. The fear of permanent extraocular palsies, neuroparalytic keratitis, and injury to the optic nerve does not seem to be warranted when the method of alcohol injection described in this report is used. No permanent complications have been noted following such injections in 41 blind eyes and 15 eyes with partial vision.

Alcohol injections into peripheral nerves relieve pain by interrupting the transmission of the nerve fibers. The proteins in the fibers are coagulated at the site of injection and the fibers degenerate peripherally from this point. If the nerve is not injected but the surrounding area is infiltrated with alcohol all of the fibers may not be destroyed but transmission is depressed. The peripheral portion of the fibers usually regenerate in a few months after injury by a migration of the axones from the uninjured part of the nerve.

Injections into sensory ganglions, on the other hand, destroy the ganglion cells and cause a permanent anesthesia of the area supplied by the nerve. Permanent anesthesia of the eye is not produced by retrobulbar alcohol injections for the ganglion cells of the sensory nerves from the eye are located in the Gasserian ganglion and not in the orbit.

It is, therefore, not necessary to inject alcohol into the posterior part of the muscle cone near the ciliary ganglion to relieve ocular pain. Infiltration of the more anterior portion of the muscle cone will interrupt the nerve transmission just as effectively and has the advantage of causing less damage to the extraocular muscles.

It is interesting that corneal sensation which is either lost or markedly diminished following the injection of alcohol usually returns to some degree within a few weeks after injection even though the pain is controlled. A similar return of corneal sensation and not pain has been noted after sectioning of the fifth nerve for trigeminal neuralgia.[9] Likewise the sensation of touch returns before pain after injections of other sensory nerves of the body.[10]

The parasympathetic motor nerves to the pupil and ciliary body are interrupted to some extent after retrobulbar alcohol injections. Contraction of the pupil and accommodation, however, return within several weeks.

The optic nerve is apparently protected to a marked extent from the effects of alcohol by its sheath. There was no reduction of vision after the injection of alcohol in 15 eyes with partial vision nor was there evidence of injury to the optic nerve in 15 eyes examined histologically. It is possible that injection of larger amounts of alcohol than were used in this series of patients might injure the optic nerve. The case of Cordes demonstrates that injection of alcohol into the nerve will destroy it. The use of a preliminary injection of novocain should indicate whether the tip of the needle is in the optic nerve or not.

In this series of cases alcohol injections did not seem to have a detrimental effect on the course of ocular lesions. However, in other studies Kornblueth and I have found that corneal transplants do extremely poorly when they are grafted into eyes of rabbits which have previously received retrobulbar alcohol injections. These poor results were not due to an anesthesia of the cornea, for all of the nerves could be sectioned in the periphery of the cornea of the recipient animal and clear grafts could be obtained.

Kornblueth[11] has made further studies on the effects of retrobulbar alcohol injections in rabbits and rats and has found that the rate of mitosis in the epithelial and stromal

cells was reduced. The healing of small lesions in the corneal epithelium was not impaired but the regeneration of the epithelium was definitely impeded when the whole cornea was denuded. This would suggest that retrobulbar alcohol injections might be detrimental to healing of large corneal ulcers.

Weekers and Magitot, however, have advocated the use of alcohol injections for corneal ulcers and have not reported a delay in the healing of these lesions. We have not used alcohol injections in enough cases with corneal ulcers to establish what effect it will have on repair, but the experimental findings in rabbits suggest that it should be used with caution in patients with corneal ulcers. They also suggest that, if a keratoplasty or keratectomy is contemplated, an interval of at least 3 to 4 months should elapse between the time of injection and operation.

Alcohol injections did not reduce the ocular tensions in patients with absolute glaucoma in this study. However, it may be indicated in less advanced cases of glaucoma which fail to respond to medical therapy, for Weekers and Magitot have reported that the tension is reduced in some patients with acute congestive glaucoma, and Kornblueth has found that the ocular tension and rate of formation of the aqueous is reduced in normal rabbit eyes following alcohol injections.

The relief of ocular pain by alcohol injection should not be allowed to influence one in deciding whether an eye should be removed in a patient with questionable sympathetic ophthalmia or intraocular tumor. It should also be established that a patient's pain is real and not imaginary before an alcohol injection is given.

Summary

Retrobulbar injections of alcohol have produced a dramatic relief of pain in 35 patients with blind eyes and in 15 patients with partial vision for at least 1 to 3 months. No beneficial effects have been noted from the alcohol injections other than relief of pain and blepharospasm. Transient extraocular palsies have occurred but no permanent complications such as injury to the optic nerve, extraocular palsies, neuroparalytic keratitis, or sloughing of the cornea have been noted.

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ACUTE SECONDARY GLAUCOMA DUE TO SPONTANEOUS RUPTURE OF THE LENS CAPSULE*

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Recent experience with three cases of spontaneous lens capsule rupture indicates the importance of this condition in the differential diagnosis of the secondary glaucomas. It was not included in the classification of the glaucomas which I have been elaborating and modifying during the past several years not only because I had never seen such a case, but because of the difficulty of classifying the cause of the increased intraocular pressure.

Two diseases of the crystalline lens must be considered in discussing spontaneous lens-capsule rupture. These are lenticular intumescence and so-called spontaneous absorption of cataract. The first, lenticular intumescence, is ultimately the cause of spontaneous lens-capsule rupture. Intumescence lasting several years leads to thinning of the capsule to such a degree that small rents in the membrane result. In the cases presented here, the cataracts in the involved eyes were present for 8, 10, and 25 years, respectively.

The ophthalmic literature contains many cases in which the lens substance was absorbed through an allegedly intact lens capsule (Hess[1]). In relation to these, cases of spontaneous lens-capsule rupture are few in number. Since the latter involve the anterior capsule, it would be expected that they would be fewer in number than those involving the thinner posterior capsule. The relative numbers of these cases suggest that the cases of spontaneous lens absorption are really cases of posterior lens-capsule rupture.

Experience with morgagnian cataracts and lens absorption after perforation of the capsule suggests that the lens cannot be absorbed without capsular rupture and that these cases of spontaneous lens absorption are really due to the presence of dehiscenses in the posterior capsule. It is probable that in posterior capsular rupture the lens material cannot find its way into the aqueous but is held back by the zonular ligament if the particles are large.

The frequent occurrence of glaucoma and iritis in connection with the so-called spontaneous absorption of cataract is further suggestive evidence of the relationship between the absorption of the lens and capsular rupture since the increase in intraocular pressure and anterior uveitis are associated with the capsule tears in the known cases of spontaneous capsule rupture.

Four instances of glaucoma occurred in the 34 cases of spontaneous cataract absorption collected by von Reuss.[2] Natanson,[3] Verry,[4] Gifford,[5, 6] and others reported similar cases.

The first reported case of spontaneous capsular rupture associated with increased intraocular pressure was that of Ulrich,[7] in 1882. Von Szily[8] reported a case and mentioned that of Ulrich and one of von Arlt. Gonzales and Gonzales,[9] Rollet and Genet,[10] Knapp,[11] and Kaufman[12] reported cases of this type.

The cause of the glaucoma in spontaneous lens-capsule rupture is important. Three possibilities are apparent: (1) Chemical irritation by lens substance, (2) increased protein content of the aqueous which tends to lessen the osmotic differential between the aqueous and the blood serum, and (3) obstruction of the trabecular spaces by particles of lens substance.

The first is the only condition which appears to be present in every case. I am, therefore, placing this form of glaucoma in the classification of the secondary glaucomas under the group of secondary glaucomas which are probably due to over-production

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of aqueous as a result of irritation of the ciliary processes:

SECONDARY GLAUCOMAS

Each may be subdivided into a noncongestive and a congestive phase. Some never enter the congestive phase.

A. Secondary glaucomas due to mechanical blockage of the trabecular spaces
1. Obstruction by iris
   a. Acute secondary glaucoma due to lenticular intumescence
   b. Acute secondary glaucoma due to dislocation of lens into anterior chamber
   c. Glaucoma following operation for cataract—aphakic obstructive glaucoma—due to delayed reformation of the anterior chamber
   d. Glaucoma associated with essential progressive atrophy of the iris
2. Obstruction of the trabecular spaces by particulate matter
   a. Glaucoma capsulare
   b. Pigmentary glaucoma
   c. Glaucoma due to obstruction by lens particles
   d. Glaucoma due to tumor growth
   e. Glaucoma due to cellular debris associated with active or healed iridocyclitis

B. Secondary glaucomas due to lack of communication between the anterior and posterior chambers
1. Secondary glaucoma due to seclusion of the pupil
2. Secondary glaucoma due to total posterior synechia

C. Secondary glaucomas probably due to overproduction of aqueous as a result of irritation of the ciliary processes
1. Glaucoma associated with posterior dislocation of the lens so latter touches ciliary processes
2. Glaucoma associated with cyclitis and anterior choroiditis
3. Glaucoma due to spontaneous lens capsule rupture

D. Secondary glaucomas due to obstruction of venous drainage
1. Experimental and clinical glaucoma due to vortex vein obstruction
2. Secondary glaucoma in pulsating exophthalmos

E. Secondary glaucomas due to newly proliferated anastomotic vessels involving the Schlemm's canal mechanism in rubeosis iridis (diabetic and arteriosclerotic) and following occlusion of the central retinal vein

F. Secondary glaucomas resulting from trauma

G. Secondary glaucomas associated with epidemic dropsy

H. Secondary glaucomas associated with choroidal angioma

CASE REPORTS

CASE 1

History. Mrs. R. K., aged 69 years, was first seen by me on July 2, 1948, through the kindness of Dr. Joseph Kopel. She was too uncomfortable to leave her bed. She complained of severe pain in her left eye of two days' duration. The right eye had been successfully operated for cataract eight years previously. The left vision had been obscured by a cataract for nearly eight years and had never been examined during that time.

The right eye was pale, soft, and showed evidence of an iridectomy and aphakia. The left eye was somewhat congested but the anterior chamber appeared clear. The intraocular pressure was 60 mm. Hg (Schiøtz). The anterior chamber did not appear to be particularly shallow. The pupil was not dilated, and showed a hypermature cataract. Physostigmine was instilled and 0.25 gr. morphine sulfate was administered. The pain was relieved and the intraocular pressure was reduced to 32 mm. Hg. Pilocarpine nitrate (2 percent) was ordered for instillation four times daily.

On the following morning the patient began to have severe pain in the left eye associated with nausea and vomiting. The eye was moderately congested and the aqueous was somewhat cloudy, although the cornea was clear. Because of lack of coöperation, slitlamp biomicroscopy could not be done. The patient was hospitalized and an iridectomy-iridencleisis operation was done.

Following the conjunctival closure there was a sudden motion of the contents of the lens which at the time suggested dislocation of the lens. Atropine was instilled. The eye was red on the following day, and the intraocular pressure remained high for a week, during which time a considerable amount of fibrinous material was present in the anterior chamber. Scopolamine and penicillin were used locally.

By July 22, 1948, the eye was much paler. There was no evidence of lens dislocation,

but the lens nucleus could now be seen clearly with little overlying cortex. No perforation of the anterior capsule could be found. Gonioscopically, the angle was open except at the limbus of the coloboma. The tension was within normal limits. Within six weeks after the operative interference the eye was entirely pale.

The diagnosis was not made in this case until the appearance of Case 2, when it was realized in retrospect that this was an instance of posterior lens-capsule rupture. The inability to do slitlamp biomicroscopy delayed proper evaluation of this case. At the onset of symptoms, the anterior chamber was clear by gross observation. The normal anterior-chamber depth and the absence of pupillary dilatation were against the diagnosis of acute glaucoma due to lenticular intumescence.

The subsequent gonioscopic appearance of the chamber angle tends to corroborate this. I can only speculate that a small perforation of the posterior capsule was causing a chemical irritation of the ciliary body producing a type of secondary glaucoma such as appears with cyclitis.

The lowering of intraocular pressure by the use of eserine for a brief time, although it suggests that chamber angle block was relieved, cannot be considered significant, since it was transient and since the angle was subsequently found to be wide and completely free of synechias except at the coloboma area.

The motion of the lens capsule following the operation was evidently a sudden increase in the size of the opening in the posterior capsule so that the liquid cortex was suddenly evacuated. The subsequent course, including the fibrinous iritis and the rapid subsidence with marked thinning of the lens, is evidence of sudden expulsion of the liquid cortex into the aqueous. Since there was no visible anterior-capsule dehiscence at this time or subsequently, a rupture of the posterior capsule must be assumed.

Comment. I have recently had an opportunity to observe the process of absorption of a lens in which the posterior capsule was ruptured. This occurred in a 15-year-old boy who was struck in the left eye on April 29, 1949. The lens was not dislocated but a vertical linear rupture of the posterior capsule was visible. The lens material bulged through the tear giving the appearance of a posterior lenticonus. The lens became opaque in its posterior aspects gradually, and separation of the fibers, with thinning of the lens, occurred. No conjunctival injection remained after the first week. The anterior chamber remained clear during the process. There was no increase in intraocular pressure. The absence of a beam in the aqueous fitted in with the observations in Case 1.

Case 2

History. Miss A. A., aged 52 years, was first seen on August 17, 1948. She complained of severe pain in her left eye for about one day. She had had a uveitis associated with the formation of a cataract 10 years previously. Tuberculin treatment was used at that time.

Eye examination. The visual acuity was 20/20 with the right eye and light perception with inaccurate projection, left eye. The right eye was entirely normal. The left conjunctiva was moderately injected. The anterior chamber was so cloudy as partly to obscure the iris and lens. No deposits were present on the posterior corneal surface. Particularly noteworthy was the inability to distinguish by optical section the separation between posterior corneal surface and anterior chamber. The intraocular pressure was over 70 mm. Hg (Schiøtz).

A diagnosis of capsular rupture was made and an anterior chamber puncture done with a 27-gauge needle from the temporal side. The aqueous was examined microscopically and found to contain finely granular particulate matter. Scopolamine was instilled.

The eye was reëxamined 30 minutes later, at which time the secondary aqueous was quite clear. A morgagnian cataract was present. Two tiny holes in the anterior capsule near the nasal margin of the pupil were

seen. Tiny tufts of lens material protruded through these openings. The eye was treated with scopolamine instillations.

Four days later the tonometric reading was 28 mm. Hg (Schiøtz). A week after this it was 14 mm. Hg. The lens capsule was apparently closed, the cortical material having been evacuated. The eye remained completely quiet for five months. The original picture then recurred. An anterior puncture was done. The aspirated aqueous contained 230 mg. percent protein. The eye became quiet within 48 hours.

Comment. The differential diagnosis of spontaneous capsular rupture may be very difficult, especially since the anterior chamber may be cloudy with anterior capsular rupture and relatively clear with posterior capsular rupture. The history of long-standing cataract with breakdown of the cortex is the necessary background for such an occurrence. Such a history in the presence of increased intraocular pressure should always suggest the possibility of capsular rupture.

With a very cloudy anterior chamber and the above history anterior-chamber puncture may make possible both diagnosis of anterior-capsular rupture and cure of the glaucoma as in the second case reported. From the literature and the experience with these two cases, it is evident that once the liquid cortex is vacuated, closure of the defect is possible.

Case 3

History. This patient, J. R., a 64-year-old man, was first seen by me on July 6, 1949. He complained of redness and pain involving the left eye, for the previous six days. He had had a cataract in this eye for the past 25 years.

Eye examination. The right eye was entirely normal, with a normal tension and anterior-chamber depth. The left visual acuity was limited to light perception, temporally. The tension was 70 mm. Hg (Schiøtz). The corneal epithelium was hazy. The anterior chamber was of normal depth with some clouding of the aqueous. A morgagnian cataract was present.

An anterior-chamber puncture was done. The aqueous which was removed was slightly opalescent. Biomicroscopic examination immediately after the anterior-chamber puncture showed an outpouring of fibrinlike material into the anterior chamber. No anterior capsular perforation could be seen in the 4-mm.-wide pupil area.

Atropine was instilled daily. The tension was 60 mm. Hg on the next day and 48 mm. Hg on the following day.

Operation. On July 11, 1949, under local anesthesia, a bevelled keratome incision was made 2 mm. from the upper limbus, penetrating the anterior capsule. The milky cortical material was allowed to escape through the wound. A small nucleus filled the pupil area. A cystotome was introduced and the nucleus pushed downward. A Daviel spoon was then introduced and the nucleus broken up by crushing it between the spoon and cornea by using a lens expressor externally. The entire nucleus was removed. The anterior chamber was irrigated.

The capsule was then observed anterior to the iris above. This was removed with a capsule-remnant forceps. No vitreous was lost. The pupil was entirely clear. Atropine was instilled.

On the following day the anterior chamber contained fibrinous exudate and the tension was hard. The wound remained intact and the chamber cleared slowly under atropinization. On the third postoperative day the tension became soft and has remained so, with brief rises to 32 mm. Hg.

Conclusion

Three cases of spontaneous capsular rupture with acute secondary glaucoma are reported.

The difficulties of differential diagnosis and the place of the condition in the classification of the secondary glaucomas are considered.

It is suggested that cases of spontaneous lens absorption are due to posterior capsular rupture.

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THE RETINAL ARTERIOLES IN COARCTATION OF THE AORTA*

14-Year observation of a case

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Coarctation of the aorta, a congenital or developmental partial or complete stenosis of the artery at or near the insertion of the ductus arteriosus, produces an elevation of the systemic blood pressure above the lesion, and relatively normal tension below the level of the constriction. This elevated blood pressure is presumably present in the retinal arterioles. There has not been much ophthalmic interest in this vascular anomaly because there are no ocular symptoms produced by it.

Since the cause of this form of hypertension is most probably a simple mechanical obstruction which increases the peripheral resistance to the flow of blood, uncomplicated by toxic, hormonal, neurogenic, and other unknown factors which operate in essential hypertension, we have at our disposal, in these rare cases, an opportunity to observe the responses of the retinal arterioles to simple increased blood pressure. Since the complicated mechanisms are not completely understood, by which the changes of essential hypertension are produced, it is possible that some information about this process might be forthcoming from the observation of what occurs in the retinal arterioles in patients who have coarctation of the aorta. It is possible, however, that the mechanism of the elevated blood pressure is not simple increased peripheral resistance but that other factors, such as renal ischemias, are operating in these cases.

It is known that there exists a relationship between the degree of the retinal arteriolar changes in essential hypertension and the two factors which seem most important in determining the effect of the hypertension on the patient. Those two factors are the severity and the duration of hypertension. It is also recognized that, in a comparatively

* From the Department of Ophthalmology, Temple University Medical School. Read before the Eye Section of the Philadelphia County Medical Society, December 4, 1947.

small group of patients with hypertension, the relationship is disproportionate between arteriolar change, on one hand, and severity plus duration, on the other. This disproportion may be either more or less than the amount that is expected.

Ophthalmologists who have studied large series of these patients and correlated the retinal and clinical findings are able to recognize these disproportionate cases. The patient whose record is reported here, represents an instance of this disproportion. It seems reasonable to assume that the disproportion, in this case, between the actual and the expected amount of sclerosis is due to the difference in the mechanisms of the two entities; namely essential hypertension and coarctation of the aorta.

One of the unknown points in hypertension is which comes first, the hypertension or the attenuation or uniform narrowing of the retinal arterioles. It is an unsettled question whether the attenuation is the cause of the hypertension or the result of the hypertension. Likewise, the mechanism of the sclerosis is unknown. While one can draw no conclusions from one case, it would seem that the findings in this case of coarctation offer material for thought on these interesting and important points. There are numerous references in the literature about the retinal changes in coarctation of the aorta and all the findings observed in our case have been recorded as occurring in previously reported cases.

Previously reported cases

Schwartz,[1] in reporting five cases, found the retinal picture to vary from normal in the mildest case, to tortuosity, spacticity, arteriovenous nicking, and increased reflex stripe in the more severe cases.

Blue,[2] in one case, found minimal early arteriosclerosis of the retinal vessels. Rhodes and Durbin,[3] in one case, reported narrowing and tortuosity. Draper,[4] in a report of one case, found normal fundi as did Shapiro.[5]

Christensen and Hines[6] found that, among 80 patients who had fundus examinations, only 22 had essentially normal fundi. Generalized narrowing of the retinal arterioles was frequent. Higher grades of sclerosis were found in cases when the diastolic pressure was over 110 mm. Hg. No patient had severe hypertensive retinopathy.

Among the many other references are listed fundus findings similar to those herein. These range from normal fundi in cases with little or no hypertension to more advanced changes in cases with hypertension. However, reports of repeated fundal examinations over an extended period of time in the same patients were not encountered in the literature. The justification for this report is that cases of long-time observation on coarctation were not found, and there was no reference to an attempt to correlate the significance of the findings in these cases with the significance of the findings in cases of essential hypertension.

Case report

History. The patient, a white man, was first examined at the age of 21 years, in June, 1933. The chief complaint was occasional diffuse pain in his legs and lower abdomen for the past four years. The past history revealed that he had also had pain in his legs at the age of 10 years which lasted for three years.

The clinical examination showed a well-developed white male weighing 155 pounds, showing redness of the face and neck. There was no cyanosis and no clubbing of the fingers. A large pulsating vessel was seen and felt in the upper right interscapular region, also on the left side at the level of the first thoracic segment. The subclavian arteries likewise showed marked pulsations. The radial arteries had a slightly increased amplitude, while the femoral arteries could not be felt. The blood pressure was, in the right arm, 200/80 mm. Hg, and 160/95 mm. Hg in the left arm. Auscultation of the heart revealed no significant murmurs and the

heart showed no enlargement.

Electrocardiograms showed a regular sinus rhythm. There was no axis deviation. X-ray examination of the thorax revealed the typical erosions of the under surfaces of the ribs which is commonly noted with coarctation of the aorta. The heart shadow was not above the upper limits of normal size.

The clinical diagnosis was coarctation of aorta, and a fundal examination was requested by the cardiologist, Dr. Roesler.

The external ocular examination, the visual fields, and the ocular media were negative. The fundal examination was negative except for the blood vessels. All the arterioles were more tortuous than normal and two were mentioned as being unusually tortuous. There was a slight accentuation of the reflex stripe on the retinal arterioles. All the arterioles, instead of being larger than normal, showed a moderate attenuation or generalized narrowing of caliber in their entire courses, and this change was very marked in their peripheral thirds. There was no sclerosis, no angiospasm, no pulsation, and no retinitis. The patient would not consent to fundus photography.

Course. The patient was reëxamined in October, 1934, and there were no significant changes. He was reëxamined in June, 1947. He complained of shortness of breath on exertion, dragging of the legs, and occasional epistaxis. He was now aged 35 years and his weight was 190 pounds. The blood pressure was 180/100 mm. Hg in the right arm, and 184/90 mm. Hg in the left arm. The heart was normal in size. The electrocardiogram showed a regular sinus rhythm; there had developed a minor degree of left axis deviation and the initial deflection showed increase in voltage in the chest leads.

The fundus examination was the same with exception that there were now present very slight focal caliber constrictions indicating retinal arteriosclerosis, grade one, on the basis of four, of the hypertensive type.

Comment

It is usual in essential hypertension of the degree and duration known to exist in this patient, that one should expect more advanced and severe changes than those which were found. There are two possible explanations for this disproportion, the first of which is the relatively low diastolic pressure. It is well known that the damage to the arteriolar tree is determined not by the height of the systolic but by the height of the diastolic blood pressure. The relatively low diastolic pressure in our patient accounts, in part, for the disproportion between the clinical and the retinal findings.

This fact is somewhat, although not entirely, balanced by the fact that the diastolic pressure in coarctation cases does not undergo the fluctuations nor remissions which occur in many types of essential hypertension. The second possible cause for the absence of more advanced changes is the absence of any hormonal, toxic, or neurogenic influences on the arterioles themselves.

The presence of the severe attenuation or uniform narrowing in this mechanical type of hypertension, where none of the factors which produce essential hypertension are active, would seem to offer strong implications that the attenuation observed in essential hypertension is not the cause of the hypertension but rather represents the reaction of the vascular tree to hypertension.

The criterion for the presence of hypertensive sclerosis in this case are the ones included in Wagener's[7] report on hypertension for the American Ophthalmological Society; namely, the presence of slight focal constrictions or localized areas of caliber narrowing. The marked tortuosity of the main arterioles is matched by the veins and is considered to be a vascular anomaly and is not an indication of sclerosis. This was present in the same degree in the later examination.

The fact that these changes occur in coarctation suggest that sclerosis per se may repre-

sent a further degree of reaction of the arteriolar tree to simple pressure. The fact that the sclerosis is of such slight degree, after such a long duration, suggests that the more advanced changes encountered in essential hypertension are the result of a combination of causes working on the arterioles as well as to higher degrees of diastolic pressure.

It is admitted that the evidence in this one case, and the changes and interferences drawn from this case are not sufficiently convincing to constitute proof of the premises which have been offered but, on the other hand, it seems that their significance is worthy of attention of students of this problem.

Summary

A case of coarctation of the aorta, in which detailed fundus examinations were recorded when the patient was aged 21 and 35 years is reported. On the first examination no sclerosis of the retinal arterioles was present but, 14 years later, there were minimal signs of sclerosis.

It is pointed out that one would expect much more sclerosis to be present than was found on the basis of observations in essential hypertension. There was uniform narrowing (attenuation) of all the arterioles on both examinations.

It is postulated, but not proved that attenuation is the reaction of the arteriolar tree to elevated blood pressure, and that the elevated pressure of essential hypertension produces the attenuation.

Likewise, it seems fair to conclude that sclerosis can be produced by, or is a reaction of the arteriolar tree to, simple elevated blood pressure. The rate and degree of the sclerotic process is increased considerably in the case of hypertension due to higher diastolic pressure and other factors which may be operating in essential hypertension.

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ENUCLEATION AND ALLIED PROCEDURES*

PART I: A REVIEW

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Removal of an eye by the mutilating and seldom utilized operation of "extirpation," which consists of slashing the eyeball from the orbit without attempting to preserve remaining orbital structures, was rendered obsolete in 1841 by the introduction of "enucleation," a procedure whereby the eye is shelled out of Tenon's capsule. During the succeeding century rather little actual progress was made in the field of eye removal.

True, descriptions of "evisceration" (1872), and of implantation of a foreign material within the sclera (1885), or within Tenon's capsule (1886), led to collection of considerable data as to the relative merits of these procedures with respect to cosmetic appearance, prevention of sympathetic ophthalmia, and prevention of postoperative meningitis. Introduction of the Snellen "reform eye" in 1898 greatly reduced the discomfort and disfigurement so prevalent with the older "shell" prosthesis. Reactions of orbital tissue to various grafts and to foreign substances embedded within it were recorded. Countless descriptions of minor variations in operative technique permitted the sifting out of a few with value. Methods were devised for at least partially correcting deformed or contracted sockets. Introduction of the plastic "acrylic" afforded a lighter, more durable, easier shaped material than glass for making well-fitting prostheses. Finally, recognition that cosmetic defects were likely to follow removal of an eye by any of the methods in use stimulated many ingenious, if largely unsuccessful, attempts to prevent or correct such blemishes.

In 1945 Ruedemann[1] described an artificial eyeball (first used in January, 1941) which he placed in Tenon's capsule at the time of enucleation and to which he actually attached the rectus muscles. He therewith initiated a new era in the enucleation field. In 1947, Cutler[2] described a semiburied implant (his "ring" implant, first inserted in October, 1945) to which the rectus muscles were attached and to which a prosthesis could be coupled after healing of the socket. This two-piece principle made it possible to assure correct orientation of the prosthesis by varying the size and shape of the anterior segment and the position of its coupling pin.

At the Wilmer Institute, utilization of Ruedemann eyes was begun in June, 1945, and of Cutler ring implants in March, 1946. The early cosmetic results were amazingly good, especially with Cutler implants, but a number of these implants extruded some months after successful insertions.

A technique was therefore devised which embodied the two-piece principle of Cutler, but also satisfied an additional new principle. When healing is complete, there is no epithelial-fibrocytic transition at any point, and the "exoplant" is in contact with nothing but epithelium rather than partially buried within tissue; this was accomplished, without any sacrifice of motility, by attaching the recti directly to each other at the juncture of two perpendicular tunnels through the exoplant, there being no actual attachment of muscles or other tissues to the foreign body. With this procedure, epithelium grows completely around the muscles as well as behind the exoplant.

From July 15, 1946, to April 1, 1948, 45 of these exoplants were inserted at the Wilmer Institute. The results have exceeded original expectations. Motility of the prostheses has equalled that obtained with the

* From the Wilmer Ophthalmological Institute of The Johns Hopkins University and Hospital. Candidate's thesis for membership in the American Ophthalmological Society, accepted by the Committee on Theses.

Cutler implant; there have been no late extrusions of this exoplant nor late infections around it, and it is suitable for delayed insertion as well as for use at the time of enucleation.

A number of modifications of the semiburied implants embodying the principles of Ruedemann and of Cutler have more recently been devised. The best of these appears to be that of Whitney and Olson,[3] wherein the muscles and Tenon's capsule are attached to a circular strip of tantalum mesh surrounding the implant.

This present report consists of a condensed review of enucleation and related procedures utilized prior to the introduction of semiburied implants with directly attached prostheses (1945), a more complete review of the procedures under development since Ruedemann opened these new vistas, and a description of a new technique involving insertion of an "exoplant" which gives cosmetic results which may prove more uniform and permanent than those attained with any enucleation procedure previously described.

Procedures without directly attached prostheses

Extirpation

The first recorded technique for complete removal of the eyeball was described by Bartisch[4] in 1583. Much earlier, Celsus[5] had described obliteration of the anterior segment of the eyeball, and Paré[6] (1579) had advocated excision of unduly prominent staphylomas.

The procedure of Bartisch, "extirpation," consisted in passing a needle and thread through the eyeball and then, while making traction on the thread, passing a knife or sharp-edged spoon into the orbit behind the globe and severing its attachments. This operation was so brutal that Bartolini[7] is cited as pulling out a cancerous eye by hooks, a procedure he considered milder than that of extirpation—although the patient died in convulsions three days later.

It is significant that while Paré,[8] the father of modern surgery, described prostheses as early as 1579 for use after loss of an eye because of trauma or suppuration, he did not mention operative removal of the eyeball. Yet he described such operations as couching a cataract, correcting an entropion, and even restoring a drainage pathway between the conjunctival sac and nose.

Certainly the operation of extirpation was so severe and mutilating it was used only for removal of eyes with cancerous or fungoid growths; globes which were merely painful or suppurating were simply incised and allowed to drain. The severity of extirpation is well illustrated by Bowman's report[9] that from 1839 to 1848 (immediately preceding adoption of "enucleation" as the means of removing an eyeball), only four extirpations were performed at the Royal Ophthalmic Hospital in London, although during that period 1,419 eye operations of all types were performed and 2,302 cases of injury, 23 cases of "fungus of the globe" and 16 cases of orbital tumor were examined.

The dread in which the extirpation operation was held was largely a result of the accompanying pain, since anesthesia was not generally available until about 1850. However, actual mutilation resulted from the complete disregard of the integrity of the orbital structures surrounding the eyeball, leading to a socket generally unsuitable for a prosthesis and consequently cosmetically disfiguring.

Simple enucleation

Tenon's capsule was first described in detail in 1806, but it then appears to have been forgotten until 1841.[10] In that year, Ferrall[11] and Bonnet[12] independently reëmphasized its significance and proposed the operation of simple enucleation. Ferrall had actually performed such an operation, but Stoeber[13] (1842) is generally credited with popularizing it. This operation consisted of making a circumcorneal incision of the conjunctiva, cutting the muscle insertions without disturb-

ing Tenon's capsule, and cutting the optic nerve close to the globe.

Enucleation did not immediately replace extirpation as the more common procedure, because introduction of general anesthetics about that time made the latter operation far less horrible, though no less disfiguring, than formerly. Not until about 1855 did enucleation come into general use for cases other than malignant growths, especially as a result of Critchett[14] advocating it for cases of staphyloma, intraocular foreign bodies, symblepharon, inflamed and painful blind eyes, and inflamed eyes where sympathetic ophthalmia was feared.

As originally described, no sutures were used following simple enucleation. However, during the succeeding century practically every conceivable type of suture for closing the conjunctiva, and/or uniting two or more of the rectus muscles, and/or closing Tenon's capsule has been described.[15-18] About the close of the 19th century considerable emphasis was placed on the exact methods of closure, but conclusions of different authors were, on the whole, variable. It seems probable that the only suture of real advantage was that which closed the conjunctiva and thus shortened the healing time.

For many years after simple enucleation was first described, minor details of technique were emphasized or argued about and many special instruments (each bearing a proper name) were devised: for example, Landolt's enucleation scissors, Brazil's enucleation knife, Luer's optic-nerve hook, Schweigger's enucleation hook, deWecker's, Terson's, and deWelt's enucleation spoons, and Joseph's hook neurotome. Even in recent years a few descriptions of minor technical details, rarely original and in no way important, have crept into the literature.[19-22]

In retrospect, the most important details of technique which have been added to the original decriptions of simple enucleation are those designed to preserve as much conjunctiva as possible. It is generally considered advisable to suture the conjunctiva horizontally because an excess of conjunctiva is available from above and below, but not from each side, for covering the space previously occupied by the cornea. In the presence of preoperative infection no sutures should be used.

Insertion of a conformer at the time of enucleation is of definite value in preventing contracture of the conjunctiva, as well as in preventing conjunctiva from prolapsing between the lids should moderate postoperative hemorrhage occur within the orbit.[23] Should postoperative infection occur, it is especially important that a conformer with a large central opening be kept in the socket to prevent contracture.[24]

Simple evisceration

Evisceration of the globe with retention of the sclera was first described as a deliberate procedure by Noyes[25] in 1872. He merely incised the anterior aspect of the globe and wiped out all contents except cornea and sclera. Graefe,[26] in 1884 advocated evisceration as preferable to enucleation as a means of obviating danger of meningitis from cutting the optic nerve in the presence of a purulent infection. Graefe removed the cornea as well as the intrascleral contents.

In 1898 Hall[27, 28] described an addition to simple evisceration which consisted of removal of a disc from the posterior sclera together with a small piece of optic nerve, after excising the cornea and wiping out the intrascleral contents of the globe. Gifford[29] (1900) advised leaving the cornea intact in order not to reduce the amount of available conjunctiva, and stated that "evisceration" was a misnomer unless the cornea was left intact. Nicati[30] advocated removal of all sclera posterior to the attachments of the rectus muscles, scooping out the anterior segment, and leaving the cornea intact.

Gifford[31] (1914) later reported using a pressure bandage to flatten the corneoscleral envelope after evisceration, thereby obtaining as a stump a large flat disc which was quite satisfactory from the standpoint of the

prosthesis. Dimitry[32] redescribed the Hall operation, and shortly afterward[33] advocated sewing the anterior and posterior lips of the sclera together to give a flat stump.

Lister[34] advised removal of all the sclera except a frill around the optic nerve when evisceration was performed because of panophthalmitis, thus cutting down the prolonged healing time incident to suppuration of the anterior portion of the sclera. This procedure was again advocated by Weve[35] in 1939. Khramelashvili[36] advised opticociliary neurectomy at the time of simple evisceration as a means of reducing postoperative reaction.

Enucleation or evisceration with implantation

In 1885 Mules[37] reported burying hollow glass spheres within the scleral envelope at the time of evisceration. He removed the cornea, inserted the implant, and sewed the sclera vertically and the conjunctiva horizontally. Out of the nine cases he originally reported, the implants had to be removed or were extruded in four and in one other there was a fistula at the site of the scleral incision.

Mules initiated his operation with the idea of utilizing the implant to take up space formerly occupied by the ocular contents and thus prevent sinking in of the socket and also to have a stump which moved as well as a normal eye. When he reported this work, before the Ophthalmological Society of the United Kingdom, he demonstrated a patient on whom he had performed this operation. In the discussion, Frost commented that he could see no better movement of the prosthesis than after simple enucleation, although the stump itself moved perfectly.

In 1886 Frost[38] reported burying hollow glass spheres within Tenon's capsule at the time of enucleation. He performed this operation on six patients, but the implant was retained in place in only one instance. In 1887 Lang[39] independently reported a similar operation with implantation of glass, celluloid, or hollow silver balls. Out of 16 cases, the implant was retained in place in 14. He advocated this procedure because he believed the cosmetic results were better than after simple enucleation and he preferred it to Mules's operation because it gave less postoperative reaction, pathologic specimens were not damaged, and complete removal of the globe obviated the possibility of late development of sympathetic ophthalmia.

During the years succeeding the reports of Mules, Frost, and Lang, the literature became redundant with reports of varied techniques for insertion of implants either into Tenon's capsule or the scleral cavity, with descriptions of implants of various materials and of different sizes and shapes, and with arguments as to the relative merits of theses types of operations as compared with each other and as compared with simple enucleation and simple evisceration.

As the years passed, improved techniques gradually reduced the percentage of implants which were extruded. Thus Verrey,[40] in 1898, collected 343 cases of Mules's operation with extrusion of the globe in 21.3 percent, while Burch,[41] in 1944, reported failures in only 9.6 percent of 52 operations.

Huizinga[42] (1900) described what was essentially Mules's operation but with removal of a disc of sclera from the posterior aspect of the globe along with a portion of optic nerve, and implantation of a fenestrated aluminum ball. He believed removal of the posterior disc reduced postoperative reaction, a view which was later expressed by Ray[43] and by Dimitry.[44] Fox[45] advised tenotomizing the recti as an addition to Mules's operation. He believed this reduced the incidence of extrusions of the implant.

Dimitry at one time preferred leaving the cornea intact in performing Mules's operation, but he soon afterward condemned this procedure because of late thinning and often eventual rupture of the cornea.[33] O'Connor[46] advocated retention of the cornea, with cruciate incisions through cornea and sclera,

and closure by suturing the apices of the corneal incisions and then covering the cornea with a conjunctival flap. Poulard[47] likewise retained the cornea, and implanted ovoids instead of spheres in those cases where he did not retain the cornea.

Burch[48] described his technique as consisting of making a scleral incision around two fifths of the circumference of the globe and just anterior to the superior rectus, removing the intraocular contents, wiping the endothelium off the back of the cornea, inserting a hollow gold ball (usually 18 mm. in diameter but varying from 14 mm. to 20 mm.), and closure of the incision with six fine white silk mattress sutures. This procedure was followed by moderately severe reaction with protrusion of edematous conjunctiva in about half the cases, but Burch believed the reaction was less marked than with the original Mules's operation. The cornea became vascularized in 3 to 6 weeks, but it did not become completely opaque, and Burch did not note thinning or late perforation of the cornea as occasionally described by others.[49]

The size of an implant to be inserted after evisceration must depend on whether or not the cornea is preserved. The implant should not fill the scleral envelope completely, because allowance must be made for some contracture. In general, the implant should be 10 to 14 mm. in diameter if the cornea is removed, or 14 to 18 mm. in diameter if the cornea is retained.

For implantation within Tenon's capsule, Frost originally united the inferior and superior rectus muscles with a silk suture, the same stitch including the overlying conjunctiva, and used another suture to unite the internal and external recti and conjunctiva. Lang also included Tenon's capsule in the sutures. Many variations in the technique of closure have been reported. Verhoeff[50, 51] closed Tenon's capsule by means of a double-armed, 3–0 chromic catgut suture passed successively through both layers of the capsule just in front of the retracted end of each severed rectus tendon, and closed the conjunctiva horizontally.

Berens[52] advocated closure of Tenon's capsule by means of a silk suture which is tied outside the conjunctiva and is removed after healing is complete. Other variations in closure have included closing Tenon's capsule with a purse-string suture, uniting the severed ends of the recti over the then-closed Tenon's capsule, and closing the conjunctiva in still a third layer.

Kirby[53] stressed the care which must be taken not to cut Tenon's capsule, because of the resulting danger of the implant becoming displaced outside the capsule and thus outside of the muscle cone. Kirby[54] also advised closure by overlapping Tenon's capsule obliquely instead of vertically and horizontally.

The percentage of extrusions of implants buried in Tenon's capsule has been found to be minimized by careful attention to the following details: (1) Waiting for complete cessation of bleeding before insertion of the implant, (2) selection of an implant which is never larger than 18 mm. in diameter, with a 14 mm. implant probably the optimum,[55, 56] (3) firm closure of Tenon's capsule and of conjunctiva in separate layers, (4) rigid asepsis, and (5) introduction of a conformer into the socket at the close of operation. Displacement of the implant outside of the muscle cone, even though it is not extruded, has been found to occur all too frequently if Tenon's capsule is ruptured and/or if too large an implant is inserted. Such displacement of an implant is certainly far more detrimental to the cosmetic result than insertion of no implant at all.

After implantation following either evisceration or enucleation, a round stump results, the prominence of which depends on the size of the implant used. If it is very prominent, a shell artificial eye serves best, but if a small implant is inserted and the stump is not prominent, a reform eye is used.[55]

The different implants which have been described are legion. These include: hollow

silver ball,[57] sponge[58, 59] aluminum frame or fenestrated ball,[60] ball of silk,[61] rubber ball,[62] agar-agar,[63] paraffin ball,[64-66] liquid paraffin,[67-70] autogenous cartilage graft,[71, 72, 219] preserved cartilage,[72] autogenous bone graft,[74] charred bone sphere,[75 76] autogenous fat graft,[77-80] hollow gold ball,[52, 81] preserved tendon,[82] hollow glass in the form of either a sphere or an ovoid, or a grooved sphere,[37, 39, 47, 83] polyviol[28, 84] (a soft plastic which causes considerable tissue reaction), acrylic[85-90] in the form of a solid or perforated sphere or pyramidal shaped, or designed so the rectus muscles can be sutured to it, hollow vitallium sphere,[91] perforated tantalum sheet in four-leaf pattern bent into cup shape,[92] celluloid sphere,[39] and dental wax.[44] In addition, freshly enucleated rabbit eyes have been sutured in place of enucleated human eyes,[93-95] and autogenous grafts of skin and subcutaneous fat have been sutured to the muscle tendons, leaving the epithelial surfaces of the grafts exposed.[96]

At present, the materials most suitable for making nonabsorbable rigid implants of inert material are vitallium, tantalum, or acrylic (completely polymerized methyl methacrylate). These materials stimulate the formation of a minimum of surrounding connective-tissue membrane. Gold and glass cause somewhat more fibroblastic proliferation, but not an excessive amount, and are almost as good for buried implants. There is no necessity for using any of the other materials which have been described for this type of implant. It was probably fortunate that Mules, Frost and Lang selected hollow glass spheres for the first implants, because buried glass does not result in a chronic inflammatory reaction inducive to extrusion of the implant. Hollow glass implants are theoretically objectionable in that they might break within the orbit but such accidents are so rare as to be negligible. I can find only one actual report of such an occurrence,[97] but Dr. Clyde Clapp has observed one additional case.[98] In Dr. Clapp's case the implant broke as a result of a blow by a fist; removal of the fragments of glass was laborious but no serious damage resulted.

Pure polyethylene plastic[99] causes as little tissue reaction as any substance known, and should serve best where it is desirable to have a flexible implant which can be molded at the time of the operation.

Implants prepared from animal or human tissues act only as foreign bodies unless they are autogenous grafts, and are in no way desirable. Preserved cartilage, for example, causes a foreign-body reaction and is gradually absorbed.[73] Charred bone (such as Guist's bone spheres) causes considerable tissue reaction ,and O'Brien[100] has reported he had to remove every one he ever inserted because of late erosion anteriorly through the tissue.

Of the various autogenous grafts generally used for burying in the orbit, the amount of eventual absorption is as follows: with fascia lata, almost none; with cartilage, very little but somewhat variable; with dermis, 30 to 40 percent; and with fat, about 60 percent. Cartilage is probably best in that it is rigid, remains viable when implanted, and undergoes little or no absorption; however, tolerance of the orbit for buried implants of the inert materials is so good it seems needless to perform the additional surgery required to obtain cartilage or any other tissue for an autogenous graft.

Prostheses

The earliest artificial eyes about which we have information[101] are those in Egyptian mummies. These are of many varieties, such as silver covered with enamel, or marble with colored glass inserts. Aztec and Inca mummies also often have artificial eyes, as do some Greek statues. Mention is made of artificial-eye makers in old Roman literature. However, the first definite mention of artificial eyes being worn by human beings is by Paré[8] (1579). He described and illustrated oval shell prostheses made of gold and silver,

painted and enameled, designed for wearing beneath the lids.

Venetians are credited with making the first glass eyes in 1619.[102] These eyes were molded and were made to order for each individual case. The Venetians' technique was exposed in 1749, and subsequently a few families, especially in France, developed this art and retained what knowledge they gained as family secrets.

Goudard[103] credits a glass blower of Nevers with making the first blown-glass prosthesis in 1740, but Dimitry[102] credits Sauzay with first describing blown-glass eyes in 1867. "Shell" eyes, made of a single layer of glass with relatively sharp edges, were the only ones available until 1898, when Snellen[104-105] first had his "Reform-Augen" made. These eyes consisted of a double shell with a hollow space between the shells and smoothly rounded edges. They represented two advances in the making of artificial eyes: the rounded edges did away with much discomfort, and the prostheses could be made as thick as desired for filling out deep-set sockets. "Shell" eyes were thereafter rarely used except to cover disfiguring or shrunken eyeballs, or in sockets with very prominent stumps.

The Mueller brothers of Wiesbaden began making artificial eyes under the direction of Snellen in August, 1898. Thereafter, most artificial eyes were obtained by choosing the best fit and match from stock collections.[106-107]

Glass eyes have certain inherent faults. A lead-glass prosthesis may last only nine months to two years because of some erosion of the glass by the lacrimal secretion.[108] Soda-glass eyes are more durable, but very fragile. As early as 1863 Davis, an artificial eye maker in this country, stressed the importance of not only obtaining an exact individual fit but also of discarding a prosthesis as soon as it developed any rough surface.[109] Continuation of wearing a glass eye after its surface begins eroding has resulted in much discharge, conjunctival ulceration, and subsequent contracture of the socket, as well as needless suffering.[110]

Hayes[111] collected 14 reports of "explosion" of reform eyes. Such an "explosion" consists of a break occurring in the posterior shell and a sucking in of orbital tissue because of the relative vacuum (approximately one-half atmosphere) within the prosthesis. Such on occurrence is frightening to the patient but is not serious.

Finally, glass eyes can be made to fit a misshapen socket only by an expert glass blower. Thier[112] described a method of actually molding the socket and making the glass prosthesis the same shape as the mold, but such a procedure was not adaptable to very widespread use.

Since 1944, glass eyes have been largely replaced by plastic prostheses of methyl methacrylate.[108, 114-122] Such eyes were only occasionally made[113, 123] before widespread production of them was first begun in that year by dental technicians in the United States Army.

A number of variations in technique may be used for making acrylic prostheses, but the general plan is as follows: An iris disc is made by painting a transparent disc (composed of ethyl cellulose, smooth water-color paper or glass) with permanent pigments, or by utilizing a photographic reproduction of a real iris. This disc is incorporated in a clear acrylic button the shape of the cornea and the anterior chamber. If a large stock of such buttons is available, a direct match can be selected for the fellow eye. Otherwise the iris disc is painted individually to match the other eye. This button is then invested into an acrylic sclera, which may be selected on the basis of stock sizes and shapes or may be prepared from an actual mold of the socket. Opacity of the scleral plastic is obtained by mixing in some titanium oxide for the whitish background and mixtures of red, blue, and yellow pigments to give the desired color. Blood vessels are reproduced on the

scleral portion with red pigment or etching ink, and sometimes red rayon threads. A clear layer of acrylic is then applied and polymerized or "cured."

A great advantage of acrylic prostheses is that they may be ground down to attain the best fit possible. If the prosthesis is shaped from an actual mold of the socket, alterations in shape toward the conventional form are often necessary. Meticulous care must be taken to polish every surface of the acrylic prosthesis.

Disadvantages of the plastic eye consist in its tendency to scratch if handled roughly, and in the occasional hypersensitivity which may develop to the plastic. The occurrence of allergy for methyl methacrylate is reported to be as common as 1 out of 100 or as rare as 1 out of 10,000.[124, 125] Incomplete polymerization is believed to be of importance in the development of such hypersensitivity.

In cases where destruction of the orbital contents is so marked that a prosthesis cannot be retained by the lids it can only minimize, never obviate, the cosmetic defect. The mutilated socket can often be concealed less conspicuously with a plain flesh-colored patch than with a prosthesis shaped and colored like lids and an immovable eyeball. However, prostheses made to cover the entire orbit will often result in a fairly satisfactory appearance. Such prostheses can be made from wax,[126] but are more easily made from latex.[127–130]

For preparation of a latex prosthesis, an impression is taken of the opposite eye and normally opened lids, and a thin prosthesis is cast from latex which has been colored to match the skin. The markings of the eyeball are then painted on and artificial lashes are attached. Latex prostheses shrink with time and the pigments become discolored, so it is usually necessary to recast such prostheses about once a year. These prostheses are extremely light in weight and can be held in place by attachment to ordinary spectacles or by a small metal band partially encircling the head.

Results of enucleation and evisceration, with and without buried implants

A. Danger of meningitis

Cutting the optic nerve during enucleation affords a potential pathway via the meninges of the optic nerve to the meninges of the brain. Evisceration was originally introduced to obviate danger of meningitis in those instances where the eye was removed because of panophthalmitis, and evisceration has been repeatedly advocated for such cases.[131] However, the actual occurrence of meningitis following enucleation is rare. Out of 10,743 collected cases of enucleation reported in 1898,[132] there were only seven deaths from meningitis, all ocurring in cases with panophthalmitis. Out of 768 collected cases of evisceration there were no instances of meningitis.

DeSchweinitz[133] (1900) collected 478 cases of evisceration with no deaths and 2,875 cases of enucleation, of which 273 were for panophthalmitis, with only one death. Out of 52 cases of panophthalmitis with death from meningitis which he collected from the literature, 33 followed enucleation. Proof was lacking that those cases of meningitis occurring after enucleation resulted from the operation rather than in spite of it. No large scale statistics are available as to the occurrence of meningitis following evisceration, but that it can occur is illustrated by the fact that Schuleck[134] had two deaths out of 36 evisceration.

In the reported cases of meningitis following enucleation, thrombosis of the cavernous sinus has been frequently mentioned. This fact raises the question as to whether meningitis was actually the result of bacteria entering the optic nerve sheaths or whether it resulted from the surgical trauma to infected orbits. If the latter is the usually correct answer, it would be better to perform

simple evisceration rather than the frill operation advocated by Lister and Weve.

In either event, in these days of available antibiotic therapy, it seems probable that fear of meningitis should rarely influence a decision as to whether enucleation or evisceration is to be performed.

B. Danger of sympathetic ophthalmia

In a majority of the reported cases of sympathetic ophthalmia following any form of eyeball removal, there are grounds for suspicion that sympathetic ophthalmia might have developed if no operation whatever were performed or that it was already present in a clinically unrecognized stage at the time the eye was removed. Nevertheless, there are adequate reports in proof that evisceration will not always prevent sympathetic ophthalmia if the eviscerated eye is potentially sympathicogenic, and that evisceration can rarely result in sympathetic ophthalmia even if the eviscerated eye was itself in no way dangerous.

Thus, deSchweinitz[133] (1900) collected 317 cases of Mules's operation with sympathetic ophthalmia occurring afterward in six instances, and in one case (that of Carrow) the original condition excluded the possibility of its having originated the sympathetic ophthalmia.

Gifford[135] (1908) collected 18 cases of probable sympathetic ophthalmia after evisceration. Nine of these cases occurred after simple evisceration and nine after Mules's operation. Most of them occurred two weeks to a year after the evisceration. Gifford was able to collect only three cases of possible sympathetic ophthalmia following enucleation, and none of these cases is really convincing.

Holdener[136] (1930) reported five cases of possible sympathetic ophthalmia following enucleation, all occurring in patients who had suffered perforations of the globe 14 to 29 days before the eye was removed. In these cases an anterior uveitis developed in the other eye between 18 to 35 days after enucleation, but in each instance the iritis was very mild and healed without loss of vision within a few weeks.

Dor[137] found a much higher incidence of subjective symptoms of photophobia, and so on, in patients who had had eviscerations than in those who had had enucleations.

Advocates of evisceration have from time to time stated the belief that this operation does not cause sympathetic ophthalmia more often than does enucleation.[138] Nevertheless, on the basis of reported cases, it must be concluded that sympathetic ophthalmia is a definite, although small, possibility following evisceration[139, 140] and that it probably never actually begins following enucleation. This fact must be weighed as definitely against evisceration in determining which method should be utilized for removal of the eye.

C. Cosmetic appearance

Cosmetic appearance after removal of an eye must be judged on the basis of appearance and movement of the prosthesis rather than on movements of the stump, as was emphasized by Noyes in his discussion of Mules's original report. Most reports concerning the cosmetic results of enucleation and of evisceration agree that motility and appearance of the stump are best after evisceration with implantation, second best after either simple evisceration or after enucleation with buried implant, and poorest after simple enucleation.

However, appearance and movement of the prosthesis bears rather little relationship to the motion of the stump because of lack of transmission of movements of the stump to the artificial eye. The artificial eye simply rests in the conjunctival sac, being held in place by the lids. It derives its movements from retraction of the various fornices, by contraction of different rectus muscles with simultaneous relaxation of the opposing muscles. The stump itself simply slides

around beneath the prosthesis. One exception occurs in sockets with prominent, convex stumps which will support shell eyes similar to contact lenses,[141] but the attainment of such stumps is uncommon. The degree of actual prominence must be exact if the stump is actually to support the shell and still not result in apparent proptosis.

There is no uniformity of opinion as to which procedure results in best motility of the prosthesis. For example, deSchweinitz[133] preferred simple enucleation, Gradle[142] preferred evisceration with implant, Dimitry [113, 114] preferred each of the procedures under discussion at one time or another, and Gougleman,[110] who actually had the task of fitting prostheses, expressed no opinion except that a small ball implant usually gave a better result than a large implant.

Retraction of the upper lid sulcus is perhaps a more noticeable cosmetic defect after removal of the eye than is poor motility. Some degree of sinking of the upper lid is apparent in all cases except those with deep-set eyes. This sinking of the upper lid has been blamed on various factors, but recent experience with prostheses attached to partially buried implants (sinking of the lid rarely occurs after these procedures) seems to prove the sinking is due to the fact that the weight of the prosthesis is supported by the lower lid and that it therefore tends to push the lower lid outward and downward and to tilt backward in its upper periphery, affording improper support to the levator. It cannot be made large enough properly to support the upper lid without pushing the lower lid so far downward as abnormally to widen the palpebral fissure. A flange or ridge on the upper edge of the prosthesis sometimes will reduce the upper lid sulcus, but more often it will produce a staring expression more repulsive than the deep sulcus, as well as reduce motility.

It is rather generally conceded that abnormal deepening of the upper lid sulcus is minimized by insertion of an implant at the time of enucleation or evisceration. However, Gougelman warns against too large an implant on the grounds that a fuller eye than normal is less pleasing than a small or deep-set eye, and that if the stump is too large it is neither possible to keep a normal fold in the upper lid nor to prevent an appearance of unnatural fullness.

Years after prostheses have been worn, there is not infrequently a relaxation of the lower lid with exaggeration of the depression in the upper lid, a backward tilting of the prosthesis, and even loss of the lower fornix with inability to retain any prosthesis in place.

A good cosmetic appearance is probably best obtained after either evisceration or enucleation if a small or medium-sized implant is incorporated in Tenon's capsule or the sclera, and the results are approximately equal following carefully performed operations of either type. However, all patients who have undergone one of these operations have at least some restriction in motility of the prosthesis, and all except those with prominent brows and deep-set eyes have some degree of displeasing sinking in of the upper lid sulcus.

Alt[143] even advised Green's[144] procedure of removing all conjunctiva, tarsi, and lid margins and sewing the skin of the lids together (complete ablation of the socket) as preferable for most working people on the grounds that the plain skin-covered socket did away with all socket irritation and discharge and was often less conspicuous than a socket containing a prosthesis.

Enucleation during early childhood is rather commonly believed to interfere more or less seriously with orbital development. For example, Vorisek[145] described a man with a very small disfiguring orbit which he blamed on removal of the eye at the age of two years. However, recent studies[144-148] have shown that while a measurable defect in bony development occurs if the eye is removed before the age of five years, and possibly even up to the age of 18 years, this deficiency in development is only in the or-

der of 0.5 to 2.5 mm. in orbital height and width, with slight overgrowth of the maxillary antrum. The defect is not cosmetically apparent. Those cases with implantations showed slightly less deficiency in orbital development than those with no implantations.

Procedure for correcting cosmetic blemishes after removal of the eyeball

A. Retraction of upper lid sulcus

In cases with sunken sockets, where retraction of the upper lid sulcus is most likely to be very disfiguring, a few ophthalmologists have considered it advantageous to increase the volume of the orbital contents by late implantations. Suker[69] prepared a pocket in the center of the socket about 3 mm. below the conjunctival surface, injected paraffin into this pocket, and sutured the overlying flaps firmly together.

Fox[45] prepared a pocket within the central stump via an incision in the upper temporal aspect of the socket and implanted a 12- or 14-mm. gold ball. Grimsdale[15] believed late implantation of a glass sphere would occasionally improve appearance but would never improve motion of the prosthesis.

Wheeler[83] described a grooved hollow glass implant with an anterior-posterior diameter of 18 mm. for delayed implantation within the muscle cone. He incised the conjunctiva horizontally and dissected it up rather widely, made a vertical incision through the fibrosed mat of collapsed Tenon's capsule, carried this incision down almost to the apex of the orbit, and inserted the implant so that the rectus muscles (if identified) fitted in the grooves.

DeVoe[149] found late implantation of a glass ball was frequently difficult because the muscles pursued an eccentric course as a result of the scarring following enucleation, that it was usually impossible to implant a sphere larger than 16 mm. in diameter without its extruding either anteriorly or posteriorly, and that such implantation did not improve movement of the prosthesis and would improve the unsightly retraction of the upper lid sulcus only slightly if at all.

Dimitry believed the cause of retraction of the upper lid sulcus was attachment of the inferior rectus to the superior rectus following enucleation; contraction of the inferior rectus, he supposed, would pull the superior rectus downward, thus indirectly pulling the levator and septum orbitale downward and backward because of the partial attachment of these structures to the superior rectus sheath.[150] Because of this theory, DeVoe[149] tried carefully severing the attachments of the superior rectus from the levator at the time of enucleation, but he found the end results were not improved.

Correction of an abnormally deep sulcus in the upper lid has been accomplished by insertion of a buried graft or implant directly within the upper lid. Smith[151] and Devoe[149] employed dermal grafts, Cutler[152] preferred fascia lata strips, Vannas[152a] used autogenous cartilage, and Sugar and Forestner[153] advocated individually shaped acrylic implants varying from 27 to 30 mm. in length and 5 to 8 mm. in width. The graft or implant is placed between the septum orbitale and the orbicularis, just below the brow, and should arch around so as to fill out the upper lid sulcus in as normal a pattern as possible. Cosmetic improvement has been reported as being uniformly worth while. The defect should be corrected as closely as possible at the time of the operation if an acrylic implant or an autogenous fascia lata graft (which do not absorb) is used, but the defect should be overcorrected if a partially absorbable autogenous graft such as dermis (which eventually absorbs by 30 to 40 percent) is used.

Surprisingly, I have been unable to find any mention of tightening the lower lid for the primary purpose of restoring a normal upper lid sulcus. Certainly tightening the lower lid to hold the prosthesis upward and not tilted backward, thereby supporting the levator and septum orbitale, is a logical and

comparatively minor procedure. It does not induce abnormal widening of the palpebral fissure. The results of such a procedure can be determined preoperatively by pinching the skin just lateral to the lower lid into a vertical fold while the prosthesis is in place. I have never seen this procedure used except where actual ectropion was present, but the results in terms of appearance of the upper lid were so good I believe it should be used rather commonly for its effect on the appearance of the upper lid alone.

B. Relaxation and ectropion of lower lid

Relaxation or actual ectropion of the lower lid, with difficulty of even retaining a prosthesis in place, is best corrected by a lid-tightening operation such as the Kuhnt-Szymanowski.[74, 154]

C. Contracted socket

Partial contraction of the socket may result from wearing no conformer or prosthesis following enucleation, the subjunctival tissue gradually becoming slightly fibrosed and rigid instead of retaining its normal elasticity.[74] However, in such instances the socket can be gradually enlarged to normal size by the wearing of increasingly large conformers, even if the eye was removed many years previously.[155, 156]

More extensive contracture of the socket may result from wearing a prosthesis with a rough surface so that ulceration and gradual scarring of the conjunctiva take place. Even greater contracture may be encountered in sockets where eyes have been removed because of severe infection with conjunctival ulceration or because of trauma from chemical, thermal, or mechanical causes.

If the contracture is not so extensive as to preclude the retention of a very small conformer, and if there is not too excessive subconjunctival scarring, the socket can often be reformed by using increasingly large conformers. Another procedure at times effective consists in strapping or splinting a normally large prosthesis into the orbit, with application of pressure to the prosthesis (via a pin attached to its anterior apex) for at least two months.[157]

For restoration of sockets so contracted that small conformers cannot be retained, various plastic operations have been devised, most of them dependent on skin grafts.

Free skin grafts are of three varieties: (1) Ollier-Thiersch grafts, first taken by Ollier with a needle and later by Thiersch with a razor, theoretically purely epidermal but actually including a small amount of dermis, (2) split-thickness grafts including epidermis and one half to two thirds of the dermis, and (3) whole-thickness grafts including epidermis and all of the dermis.

The thinner grafts vascularize more quickly and are more likely to remain viable. With a free graft there is more contracture than with a sliding or pedicle graft, and even with a pedicle graft there is a tiny bit of contracture from scarring along the plane of junction of graft and underlying tissue.[158]

Maxwell[159, 160] first described an operation for forming a lower cul-de-sac and increasing the vertical diameter of the socket (by 4 mm.). His operation consisted in preparing a crescent-shaped skin flap, with the upper margin 5 mm. below the lower lid border, and 8 mm. wide in the center, left attached to the subcutaneous tissue in its center; this was inverted through an incision extending through the lower lid, from the upper edge of the flap into the lower part of the socket, so that the epithelial surface could be sutured to the edges of the conjunctival incision.

Schwenk[161] used Maxwell's method for restoring the lower cul-de-sac and, in those cases where almost all of the conjunctiva was lost, also employed a pedicle flap from above the brow for restoring the upper cul-de-sac.

Weeks[162] used a full-thickness skin graft to restore either the lower or upper cul-de-sac. He inserted a rubber mold at the time of operation and overcorrected the defect about 50 percent. Disadvantages of this pro-

cedure consisted in undue thickening of the lid because of the thickness of the graft, often an unpleasant discharge with some odor, and growth of hairs from the graft.

Czapody,[163] in 1935, again advocated use of full-thickness grafts, and kept the cul-de-sacs stretched postoperatively by means of a two-piece form which could be spread like the blades of a speculum. Lugossy,[164] however, criticized the Czapody operation because late scarring often resulted in an immovable and very disfiguring appearance of the lids.

Esser[165-167] introduced his "epithelial inlay" in 1916, and was the first to describe use of a Thiersch graft for replacement of conjunctiva in contracted sockets. His procedure consisted of full dissection of upper and lower cul-de-sacs and insertion of the graft wrapped around a mold of dental stent.

Esser's procedure has been redescribed many times with minor variations[168-179] and is still the most commonly used operation for restoring severely contracted sockets.

Several details of technique which have been emphasized are worthy of mention.

Dissection beneath the lids should be kept very superficial in order not to end up with lids which are too thick; all scar tissue and granulation tissue should be removed and, if tarsal conjunctiva is involved, the tarus should be split and thinned to reduce the resulting thickness of the lids. The dissection should be carried down one-fourth inch below the infraorbital ridge, up to the levator and one-half inch to each side of this muscle. The graft should be as thin as possible and 50 percent larger than the defect.

The epithelial surface of the Thiersch graft is usually kept against the mold or conformer either by suturing the graft around the mold or by sticking it on with rubber cement, but the graft margins may be sutured directly to the edges of the defect.

A conformer or prosthesis should remain in the socket at least three weeks, keeping the cul-de-sacs stretched. Various conformers of rubber, latex, or acrylic have been advocated in place of a mold of dental compound. Flexible conformers such as one simply cut from a hollow rubber ball[174] are probably best, because these can be quite large and yet can be inserted without a canthotomy. After healing is complete, small blisters will indicate the positions of occluded lacrimal ducts, and these can be opened with a hot needle to allow a moist socket.

O'Connor and Pierce[170] advocated use of any available conjunctival flap from elsewhere in the socket, or otherwise a very thin bipedicled skin flap from the upper lid, to replace tarsal conjunctiva of that lid, because a Thiersch graft over the upper tarsus often contracts sufficiently to buckle the upper tarsal plate and concentrate the cilia in the center of the lid.

A combination of skin and mucous membrane as a lining for the socket has most generally been condemned, but Marcks and Zugsmith[74] have recently reported obtaining more flexible sockets by leaving a central area of intact conjunctiva if any is available, or, in case there is no conjunctiva, using a two-stage procedure of suturing a central epidermal graft in place and later reforming the fornices with Esser's procedure. They found that, in sockets with a combination epidermal and mucous membrane lining, there was a period of increased secretion which gradually reduced, with the epidermal graft becoming soft and flexible within a year. They also emphasize the importance of a normal-appearing caruncle for proper cosmetic appearance, and advise that, if it is bound down with scar tissue, it should be freed by means of a "Z" plastic or a mucous membrane graft.

Free mucous membrane grafts have occasionally been advocated for repair of contracted sockets. For women, Clay and Baird[180] advised use of two grafts, each about 3 by 5 cm., taken from each side of the vagina, from between the inner margins of the labia minora and the outer margins of the hymen. In men, they preferred mucous membrane from the prepuce but, if the con-

junctival defect was large, insufficient mucous membrane could be obtained from that site. MacKenzie[181] lists the preferable sites for obtaining donor grafts as follows: in the male, (1) mouth, (2) prepuce; in the female (1) vagina, (2) mouth.

De Roetth[182] employed fetal membranes for repair of conjunctival defects, the chorion surface being placed against the raw surface and the amnion forming the free surface, but found very marked shrinkage after three weeks. Law and Phillip[183] used amnioplastic and noted some shrinkage after three months but retention of a fornix of fair depth.

Berens[184] devised an operation to restore the lower cul-de-sac which preserved the overlying conjunctiva, and thus obviated the necessity of any grafting, for use in those cases where the lower fornix was obliterated by subconjunctival scar tissue but where there was no serious shortage of conjunctiva.

He made a 2-cm. vertical incision into the lower cul-de-sac at the outer canthus. Working through this incision, he undermined the conjunctiva and removed all scar tissue down to and along the entire extent of the anterior surface of the lower orbital margin. He then passed three double-armed silk sutures through the mobilized conjunctiva, into the depths of the reformed cul-de-sac, and out through skin at the orbital margin, tying the sutures over rubber pegs (Snellen sutures). With this procedure, he found it unnecessary to insert any conformer or prothesis at the close of operation.

For reformation of an obliterated lower fornix, Nordlow[154] dissected the conjunctiva from the lower lid and carried his dissection down beneath the orbital margin, shortened the lid with a Kuhnt-Szymanowski operation, and sutured the conjunctiva into the resulting cul-de-sac with Snellen sutures. Weskamp[185] described Damel's technique for restoration of the lower cul-de-sac as incising the conjunctiva horizontally 6 mm. back of the lid margin, undermining the palpebral conjunctiva, dissecting the lid free to the orbital margin, and suturing the edge of the undermined conjunctiva to the inner surface of the skin of the lid near the orbital margin. The remaining bare surface in the lower portion of the socket is simply allowed to epithelialize over.

Occasionally it is desirable to widen the external canthus. Noyes[186] described the use of a small temporal skin flap for this purpose.

D. Depressed fracture of orbital floor

Not infrequently, eyes are enucleated because of an injury which is sufficiently severe to fracture the floor of the orbit into the maxillary sinus, with prolapse of orbital structures downward and backward; there is usually an associated comminuted fracture of the zygoma.

If such a fracture is recognized within 2 or 3 weeks of the injury, the proper orbital shape can generally be restored by packing iodoform gauze in the antrum. Later, such a defect is more easily repaired by a subperiosteal implantation along the depressed orbital floor, but the bony orbital floor should be completely healed before an operation of this sort is performed.

For building up the orbital floor fascia lata, cartilage, bone, tantalum, acrylic, and glass wool (fiberglas) have been utilized.[155, 187, 188] Autogenous cartilage or fascia lata grafts have the least chance of resulting in infection, while glass wool or tantalum wool is easier to insert in proper position for correcting the defect.

E. Partial or complete exenteration

After exenteration of the orbit the defect is generally best covered by a latex prosthesis or simply an inconspicuous patch. However, a few surgical procedures, none of them very satisfactory, have been advocated for partial cosmetic repair.

Golovine[189] utilized a pedicle skin flap from the temporal region which he carried through a vertical incision behind the outer

canthus and sutured into the orbit along the edges of conjunctiva, the lids having been preserved. After the graft had taken well, the pedicle was cut, the skin incision outside the canthus was closed, and an artificial eye could be retained within the lids.

Goldstein[190] freed the lids, after healing was complete, and lined the undersurface of each lid with Thiersch grafts. He then split the lids and inserted Thiersch grafts, and the patient was able to wear a prosthesis which would fit into these slits.

Hagedoorn[191] described a four-stage operation for use after complete exenteration but with retention of skin of the lids. The first stage was implantation of fat and connective tissue beneath the lining of the lower part of the orbit; the second stage was mobilization of the overlying epithelium and moving the fat back to the apex of the orbit; the third stage was mobilization of the skin of the lids and completing the filling of the orbit by means of another fat transplant; and the fourth stage was an Esser operation for contracted socket.

Kolen[192] described an ingenious method of reconstructing the eyelids by making pockets beneath abdominal skin and lining the insides of the pockets with mucous membrane grafts. Later, slices of cartilage from the ear were grafted between skin and mucous membrane, and finally the ready-made lids and socket were transferred to their final position via pedicles. Filatov[193] also advocated use of this procedure for reconstruction of a completely exenterated orbit, but he had not actually performed such an operation.

(To be continued)

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EVALUATION OF NIGHT VISION*

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INTRODUCTION

The physiology of rod and cone vision has been under investigation for many years. Schultze[1] was the first to suggest, in 1866, that the retina possesses two types of receptor cells, but it was not until 1895 that the duplicity theory was finally established by von Kries.[2] In brief, this proposed that the cones are concerned chiefly with visual acuity and color discrimination at high intensities of illumination while the rods are responsible for vision at low intensities. Parsons introduced the terms "photopic" for vision at high intensities and "scotopic" for vision at low intensities of illumination.

The phenomenon of retinal adaptation was first measured by Aubert[3] in 1865. During the latter part of the 19th century other investigators, notably Koenig and Ritter[4] and Abney and Festing,[5] were concerned chiefly with the effect of wave length on the threshold of the dark-adapted eye. With the development of more precise physical equipment, this work has been repeated several times, the most accurate measurements being those of Hecht and Williams[6] and Kohlrausch.[7]

Shortly after the original measurements of retinal adaptation,[3] Boll[8] discovered visual purple (1876), and Kühne[9] was successful in extracting it from the retina (1879). It was natural, therefore, to associate it with the visual process. In fact, Parinaud,[10] in 1895, suggested that night blindness was caused by a deficiency in visual purple.

The correlation of the physiologic studies of retinal sensitivity with the photochemistry of the retina is a most fascinating story,[11] the nature of which was gradually revealed by the work of many investigators. Lythgoe and Tansley,[12] in England, and Hecht[13] and Wald,[14] in this country, have been the principal contributors to this problem.

Coincident with the evolution of our knowledge concerning dark adaptation and the chemical nature of the visual process was the interest shown by the nutritionists in the isolation of the vitamins. It had been known for many years that a nutritional deficiency might cause impairment of night vision. Studies on the relationship of vitamin A to visual purple and the isolation of vitamin A from the retina by Wald[14a] provided further impetus to the study of dark adaptation as a measure of vitamin-A deficiency. The literature on this subject has recently been reviewed by Schmidtke.[15] The results varied with the socio-economic status of the group tested, the apparatus used, and the enthusiasm of the reporter. It became apparent that vitamin-A deficiency did raise the light threshold of the dark-adapted eye. However, the subjective nature of the test and the many variables that had to be considered did not permit its acceptance as a routine method for the determination of vitamin-A deficiency.

Numerous instruments have been devised for testing the light sense. Until the advent of our interest in the test as a measure of vitamin-A deficiency, most of these were well-standardized models relegated to the research laboratories of those interested in visual physiology. The popularization of the test, however, led to the development of some instruments that could not fulfill the claims of the manufacturers. The literature on the instruments available prior to World War II has been adequately reviewed by Sloan.[16]

With the onset of the war, it was soon realized that, although great advances had been made in our knowledge of visual capacities at scotopic levels of illumination,

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there were still many problems of a practical nature that were left unsolved. The hours from dusk to dawn assumed a new importance. The evaluation of night vision became of paramount interest both from the point of view of identification of enemy aircraft and the operation of aerial attacks against the enemy.

The problem presented to the military services, especially with regard to aviation, can be briefly stated as (1) what variation in the visual threshold might be expected in a highly selected group of individuals, (2) what type of night-vision test suitable for mass testing could best reduplicate the visual tasks required in night operations, (3) providing a satisfactory test were developed what would be its reproducibility and reliability, (4) what would be the validity of the test, (5) what means, if any, could be used to improve the visual threshold of supposedly normal individuals?

The investigative work to be reported here relates to the first, third, and fifth parts of this problem. It will be described in the order in which it was carried out and will be followed by a general discussion of the problem as outlined in the preceding paragraph.

Experimental work

Objectives

1. To determine the variations in certain criteria of dark adaptation in a group of individuals of the same age who had passed the rigid physical examination for aviation cadets and who followed the same dietary regimen.

2. To determine whether large doses of Vitamin A as a supplement to an adequate diet would improve the visual threshold.

3. To study the reproducibility and reliability of two different tests of night vision.

The dark-adaptation tests were conducted on 162 aviation cadets stationed at Randolph Field, Texas, during the summer of 1941. These cadets, selected at random by their officers, were all supposedly in perfect health, with uncorrected visual acuity of 20/20 or better and with no evidence of ocular disease. The examinations were made by me during the second 10-week period of their flying training. The cadets, all of whom lived in permanent barracks, were fed in a central mess hall. The food was excellent and unlimited quantities of milk, butter, eggs, and green vegetables were provided. In accordance with military procedure the cadets were allowed off the post only on Saturday nights; on other nights—except while flying at night—they were in their barracks by nine o'clock.

The examinations were conducted in a photographic darkroom, adequately ventilated to insure comfort. Unless stated otherwise, the dark adaptometer devised by Hecht and Shlaer[17] was used and the procedures recommended by them followed. On calibration of the standard lamp, the logarithm of its intensity in micromicrolamberts ($\mu\mu$ l) was 12.962. The right eye of the examinee was used in all experiments, the chin rest being adjusted to the right height by means of a pinhole disc temporarily inserted into the eyepiece of the instrument.

For light adaptation, the right eye was adapted to an intensity of 982 millilamberts for three minutes. The test field was three degrees in angular diameter and fell seven degrees to the nasal side of the macula. A violet filter (Corning 511) was used in the test field which was exposed in flashes of one fifth of a second. The intensity of the testing light was controlled by means of a neutral wedge and filters. This intensity was usually set by means of the wedge below the expected threshold value for the first flash and then was increased by steps of 0.1 (log $\mu\mu$ l) until the observer reported seeing a flash.

The rod threshold was determined by the "method of limits" described in the following part of this paper. Dark adaptation was measured over a period of 30 to 35 minutes. Threshold readings were recorded as the logarithms of the intensity expressed in micromicrolamberts (ordinates) and plotted

against time in minutes (abscissa).

Range of dark adaptation threshold. The first factor to be determined was the variation in the range of the dark adaptation threshold in such a group of cadets, whose ages ranged from 19 to 25 years. The entire course of dark adaptation was recorded for all individuals. The criteria selected for study were the cone threshold and final rod threshold. In the entire sample 81.5 percent had final rod threshold values between 2.7 to 3.0 (log μ μ l) and 75.3 percent had cone threshold values between 5.6 and 5.9 (log μ μ l). If the data are analyzed statistically, the logarithm of the mean cone threshold in micromicrolamberts was 5.75 with a standard deviation (σ) of 0.198 logarithmic units. The logarithm of the mean rod threshold in micromicrolamberts was 2.84 with a standard deviation (σ) of 0.156 logarithmic units. The correlation coefficient of the two final thresholds is 0.20. This value is on the border line of statistical significance. The low correlation between these two thresholds had been previously reported by Hecht.[18]

Three categories were arbitrarily chosen to classify performance in the dark adaptation tests. Listed as *good* were all observers whose final rod threshold fell within one standard deviation above or below mean (2.68 to 3.00 log μ μ l); as *excellent*, all those whose thresholds were lower than one standard deviation (2.68 log μ μ l or less); and as *fair*, those whose thresholds were greater than one standard deviation from the mean (3.00 μ μ l). None of those examined had thresholds high enough to suggest any evidence of night blindness or to warrant their performance being classified as poor. The cone threshold was not considered in this classification.

Vitamin-A effects on night vision. In a study such as this, it is only natural that one of the features to be investigated should be factors that might improve the visual threshold. Of the group of 162 cadets examined in the preliminary survey, the last 40 were detailed for this experiment. When reporting for further night-vision tests, every alternate cadet was used as a control subject. No selection was attempted to include persons with high or low thresholds. The subjects were examined twice before starting the experiment. One group received 50,000 units of vitamin A a day as a supplement to their usual diet, the other group received only the ordinary cadet mess diet. The vitamin A was taken in the presence of an officer immediately following the noonday meal. The entire group was examined weekly for a period of eight weeks.

The total number of examinations in the control group was slightly less (9) than in the vitamin-A group because of examinations unavoidably missed. Half the group was examined in the morning and half in the afternoon, since this fitted their flying schedule. One week each group was seen before exposure to much sunlight and the following week was seen after 1 to 2 hours of flying. This balanced the rise in threshold that might occur following exposure to bright sunlight for a period of several hours.[19]

The statistical analysis is based on 38 individuals since two "washed out" before the experiment was completed. The results are listed together in Table 1. In order to appreciate fully the improvement that may take place as familiarity with the test increases, the data have been further broken down so that one can compare the mean thresholds of the first two and last two examinations.

In the group receiving vitamin A, the drug was not started until after the second examination. Those receiving vitamin A showed an improvement in their mean cone thresholds of 0.158 logarithmic units while the control group improved by 0.108 logarithmic units. The difference (Δ) 0.050 between these two values is not significant statistically since it is less than twice the standard error of 0.051.

Similarly the improvement in the mean rod threshold of those receiving vitamin A was

0.150 logarithmic units while the control group showed an improvement of 0.108 logarithmic units. The difference (Δ) 0.042 between these two values is also less than twice the standard error of 0.050, again not statistically significant. The improvement in the control group can be ascribed only to the "learning" factor which is a common observation in subjective tests of this nature.

TABLE 1

LOGARITHM OF THE MEAN CONE THRESHOLDS IN MICROMICROLAMBERTS

Vitamin A		Controls
$5.727 \pm .0133$	Eight-week period mean cone threshold	$5.721 \pm .0162$
146	number of examinations	137
.161	standard deviation (δ) (logarithmic units)	.190
	First two examinations	
$5.803 \pm .024$	mean cone threshold (log I $\mu\mu$ l)	$5.797 \pm .024$
38	number of examinations	38
.148	δ (logarithmic units)	.146
	Last two examinations	
$5.646 \pm .024$	mean cone threshold (log I $\mu\mu$ l)	$5.689 \pm .030$
38	number of examinations	38
.148	δ (logarithmic units)	.186
Δ_v .158	improvement (log I $\mu\mu$ l)	Δ_c .108
Difference $\Delta_v - \Delta_c = .050$		
S.D. of the difference δ ($\Delta_v - \Delta_c$) = .051		

LOGARITHM OF THE MEAN ROD THRESHOLDS IN MICROMICROLAMBERTS

Vitamin A		Controls
$2.720 \pm .0124$	Eight-week period mean rod threshold	$2.746 \pm .0155$
146	number of examinations	137
.150	standard deviation (δ) (logarithmic units)	.182
	First two examinations	
$2.810 \pm .0165$	mean rod threshold (log I $\mu\mu$ l)	$2.800 \pm .0265$
38	number of examinations	38
.101	δ (logarithmic units)	.158
	Last two examinations	
$2.660 \pm .0238$	mean rod threshold (log I $\mu\mu$ l)	$2.692 \pm .0323$
38	number of examinations	38
.146	δ (logarithmic units)	.200
Δ_v .150		Δ_c .108
Difference $\Delta_v - \Delta_c = .042$		
S.D. of the difference δ ($\Delta_v - \Delta_c$) = .050		

Reliability and reproducibility of night-vision tests. In any test of night vision, it is essential that the test be reliable and that the results be reproducible. In the experiment reported (*Vitamin-A effects on night vision*) it was found (in the control group) that there was no significant improvement in the mean cone or rod threshold after the first two tests. One might expect slight improvement with practice but this was to all intents and purposes negligible after the second test.

The fact that one particular test of night vision is reproducible and reliable does not necessarily mean that all other tests of a similar nature will have the same reliability. Even if another test proves to measure reliably the functions it purports to measure, there may be a poor correlation between the two tests. This is especially true if the two

tests are measuring visual functions at different levels of illumniation.

To evaluate the reliablity and reproducibility of a night-vision test using form discrimination, 85 cadets were examined by another test using the method of "frequency of seeing" [43b] described later. This required the recognition of a Landolt C subtending a visual angle of two degrees. The test object was automatically presented five times at eight different levels of illumination, starting at a level high enough so that all presentations should be seen readily and finishing at a level at which, in most instances, none could be seen. The test therefore has yielded a score between 0 and 40.

TABLE 2

SCORES ON SUCCESSIVE TESTS ON THE AAF NIGHT-VISION TESTER

Case Number	Test Number				Case Number	Test Number			
	1	2	3	4		1	2	3	4
1	20	28	28	31	44	9	11	13	10
2	13	25	17	24	45	15	20	19	20
3	8	22	19	22	46	24	19	17	29
4	7	19	23	26	47	27	27	23	31
5	12	22	19	24	48	10	7	13	16
6	19	23	20	21	49	27	24	25	33
7	16	14	11	13	50	18	22	26	27
8	16	22	15	24	51	17	20	16	14
9	20	15	19	22	52	21	27	21	22
10	32	34	34	34	53	21	30	32	32
11	14	25	21	24	54	24	25	23	26
12	24	21	19	21	55	13	21	17	23
13	27	32	27	24	56	18	17	21	16
14	15	22	24	21	57	20	26	26	24
15	14	14	12	13	58	23	28	30	27
16	16	15	13	21	59	26	30	24	28
17	25	25	20	23	60	6	4	10	6
18	13	19	16	23	61	20	21	22	25
19	16	24	26	28	62	20	24	24	25
20	26	25	20	27	63	16	17	15	23
21	10	14	19	20	64	16	22	20	19
22	22	30	31	32	65	28	31	36	32
23	14	25	22	24	66	24	27	30	32
24	25	20	18	21	67	17	20	21	25
25	9	22	17	20	68	12	22	18	20
26	24	29	22	30	69	17	29	26	31
27	5	6	7	10	70	32	29	31	31
28	30	32	27	30	71	15	25	17	21
29	16	22	22	19	72	27	26	30	29
30	12	17	13	12	73	22	25	22	18
31	17	21	22	24	74	9	22	17	20
32	9	15	17	10	75	16	13	14	19
33	21	24	21	20	76	11	18	21	23
34	17	15	21	19	77	7	10	8	8
35	18	19	18	17	78	34	32	36	36
36	16	19	14	15	79	25	32	36	31
37	3	4	8	4	80	25	22	23	28
38	14	24	25	23	81	19	17	21	20
39	21	20	18	21	82	31	28		26
40	25	27	22	26	83	27	33		25
41	22	23	26	29	84	16	26		15
42	8	6	11	11	85	4	14		14
43	7	20	13	12					

The test was carefully explained to the cadets and, after thorough dark adaptation, the value of parafoveal vision was demonstrated by means of a preview of the test. Table 2 lists the scores on the four tests. It must be pointed out that the first and second

tests were given on the same day and the third and fourth approximately one week later.

The statistical analysis of the data is presented in Table 3. This shows that the practice effect is greatest between the first and second tests, the mean difference between the scores being less than 3.72. Subsequent retests are of little value. The mean difference between the scores on the second and fourth totals is 0.68. The relation between the second and fourth tests can be seen in Figure 1. The correlation between these two tests is 0.797, which is very good. Again this shows that after the second test there is little subjective improvement in a test of this nature.

TABLE 3

RELIABILITY OF AAF NIGHT-VISION TESTER

(Comparison of scores on first, second, and fourth tests)

Mean difference, trials 1 and 2		=	3.72
S.E. of mean difference		=	0.54
Interpretation	P	=	.01
Mean difference, trials 1 and 4		=	4.40
S.E. of mean difference		=	0.55
Interpretation	P	=	.01
Mean difference, trials 2 and 4		=	0.68
S.E. of mean difference		=	0.46
Interpretation	P	=	.20 to .10

$n = 85$

$\bar{x}^1 = 17.96$

$\bar{x}^2 = 21.68$

$\bar{x}^4 = 22.36$

DISCUSSION

Before adopting any test of night vision, it is essential to know what variation might be expected in the population to be tested. Several surveys of fairly large numbers of supposedly normal individuals have been published. The results have varied somewhat,

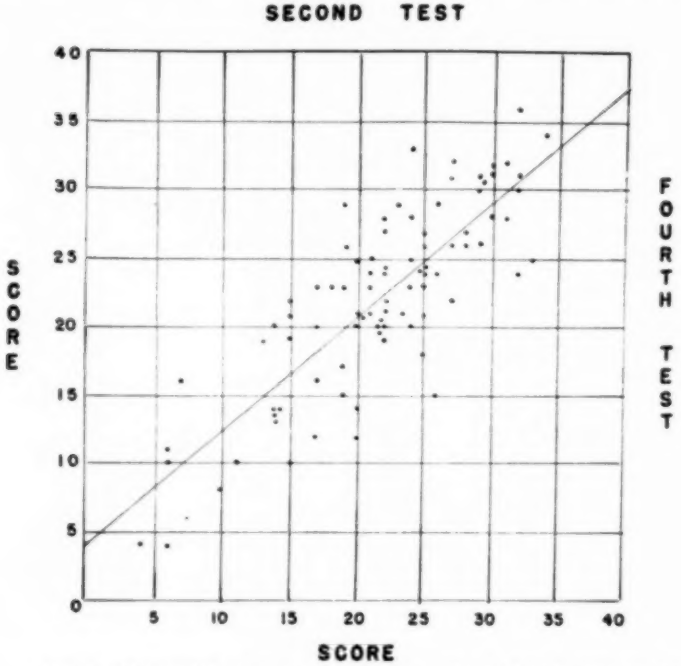

Fig. 1 (McDonald). The scores of the second and fourth tests on the A.A.F. night-vision tester, plotted together to show the correlation between the two tests.

depending upon the type of instrument employed. The one used in this survey was the same as that used by Hecht and Mandelbaum[18] in their study of 110 university people. Solandt and Best[20] used a later modification of the same instrument, while Yudkin and Robertson[21] used one embodying the same general principles. The results of these surveys are in close agreement. Bishop Harman,[22] Rycroft[23] and Lister,[24] in England, have also reported on large groups of individuals. Their respective instruments required the recognition of a form at a low level of illumination. Their data, though significant, are hardly comparable, since the results are not expressed in units of brightness or illumination.

The Hecht instruments measure the threshold with a well-controlled patch of light. As Godding[25] has pointed out, however, there is a difference between the measurement of the absolute threshold and the recognition of various forms or letters at low intensities of illumination. This fact alone may account for the apparent differences in the results that have arisen in the various studies of night vision. This will be amplified in the discussion of the various instruments that recently have been developed.

At the time my experimental work was done, the only available material was that of Hecht and Mandelbaum.[18] The data on both these groups were compiled on the results of the individual's first performance of such a test. The results show striking similarity. As might be expected in a group of younger individuals, the final rod threshold is slightly lower, although the cadet group was essentially the same as the 21-to-25-year age group reported by Hecht and Mandelbaum.[18] Since the cadets were a highly selected and physically homogenous group, all eating the same food and living under the same conditions, a greater difference might have been expected between these two groups.

The spread of the final rod threshold was approximately one log unit which is also the same as reported by others.[18, 21] This means that the threshold of the poorest individual was 10 times higher than that of the best. When one considers that the total threshold change is at least four log units, or 10,000 to 1, this variation is comparatively small. One may expect therefore that the visual threshold may vary by a factor of 10 in a group of aviation cadets.

The study of visual perception under conditions of threshold illumination has not been evaluated without some difference in opinion attested to by the several instruments that have been developed to measure this function. Each one has had certain purported advantages such as ease of administration, rapidity and simplicity of the test, and so on. Hecht,[18] Craik[26] and Tansley[27] have repeatedly emphasized that the fundamental physiologic principles must be fully appreciated and followed to insure reliable measurements and the basic criteria for a satisfactory test of dark adaptation have been fully discussed by them. Briefly the factors to be considered are: 1. Time and intensity of the preadapting light; 2. location of the retinal area tested; 3. size of the retinal area stimulated; 4. time of exposure of the test flash; 5. wave length of the testing light.

These criteria must be followed to devise an accurate test of some basic visual function at low levels of illumination such as the measure of the absolute threshold to a flash of light, or of some simple visual task such as the recognition of the direction of an arrow, at any given low level of illumination. The advantages of such a test are that in measuring one visual function over a fairly narrow range of illumination, the test would be fairly simple to give and might readily lend itself to mass testing. Another argument in favor of a simple test of threshold or visual acuity at low levels of illumination is based on Shlaer's[28] studies, which showed that visual acuity at such levels varies as the logarithm of the intensity; therefore, such a test might give sufficient

information as to visual acuity at higher levels of scotopic vision.

Additionally, the requirements for a test of night vision peculiar to the needs of the military services demanded that it reproduce as closely as possible the visual discrimination encountered in night operations.

The most difficult task was to define what visual discriminations might be encountered in night operations. These may vary from determination of the absolute threshold to the recognition of forms of varying size and contrast, from low levels of illumination to the wide ranges of sky brightness found in starlit or moonlit nights. It is obvious that no one test could fulfill this range of requirements. However, one could aim at a test of form discrimination at intensities well within the range of scotopic vision. A test which approximates these conditions has been called by Livingston[29] "a test of night visual capacity," a term that would seem more appropriate to denote the visual discriminations required.

Such a test would have the advantage of approaching more closely to actual operating conditions and by so doing should make performance on the test correlate better with actual practice. One of the disadvantages is that it must needs be a compromise, since it would not be feasible to measure any one visual function over the wide range of intensities encountered in night operations.

Another disadvantage is that extraneous factors would be introduced that would have no real bearing on the visual task to be measured. Craik[26b] and Godding[25a] have clearly shown that the perception of a silhouette or other more complicated material is not a test of dark adaptation. Consideration must be given to visual, adaptive, psychologic, and training factors in any such test. True, good dark adaptation is a requirement for a high standard of night visual capacity but, as Craik[25b] has shown, there is little correlation between such tests and the absolute threshold of rod vision.

These objections, however, were outweighed by the desire to produce a test that would more closely approximate the visual discriminations encountered in night operations. How best could this be done without disregarding the basic fundamentals for a satisfactory test of dark adaptation?

The first point to be considered was the necessity of *preadapting the eye* or eyes to a light of unknown intensity for a fixed interval of time. The purpose of preadapting the eyes to a bright light is to bleach the visual purple in the retina with a known quantity of light. This enables one to measure the course of dark adaptation from a known standard level and permits comparable measurements which are independent of the level of the environmental illumination. This difference in rate of adaptation is clearly demonstrated on entering a darkened theatre on a bright, sunny day or during a dimout.

If one is not particularly concerned with the course of dark adaptation, a common level of dark adaptation can be obtained by keeping the subjects in a darkroom for a minimum of 30 minutes, after which there is, for most practical purposes, little change in the rod threshold. An important consideration here is that, in measuring thresholds during the course of dark adaptation, the final rod threshold has been found to be the most reliable measurement.[21, 25a, 30, 31]

Another argument against the measurement of the rate or course of dark adaptation is the time factor—numerous determinations would have to be made and the value of this information in contrast to a few more accurate measurements at the desired levels of illumination is questionable. (This was evident in the measurements of the complete course of dark adaptation on the 162 cadets in the experiments reported above.)

Because of these factors and because of a desire to measure visual efficiency at various levels of low illumination rather than the rate of adaptation or a threshold at one fixed

level, it can be assumed that, for the purposes of the military services, preadaptation could be dispensed with and an equal retinal level could best be reached by a carefully regulated period in which all subjects were kept in darkness.

This is the procedure that has been followed in most of the night-vision tests used by the various armed services. The wearing of red goggles[32, 33] transmitting light only beyond 620 μ can considerably reduce the time to be spent in actual darkness. The effectiveness of the goggles depends upon their cutting down the total amount of light transmitted and upon the difference in the stimulating power of white and red light on the rods.[34]

The *location of the retinal area* to be tested can be determined by the use of some fixation device.[35] If binocular vision is used, corresponding areas of retina will be stimulated. Hecht[17, 18] has emphasized that the control of fixation gives greater accuracy to the test since a predetermined area of the parafoveal retina is stimulated. Godding,[25a, b] however, feels that if a larger test field is used, that is, one subtending a visual angle of seven degrees, fixation devices can be dispensed with.

The use of a fixation device would not be in keeping with the desire to reproduce as closely as possible the actual conditions encountered in night operations. It must also be borne in mind that the region of the retina having the maximum scotopic acuity may vary from individual to individual and an alert examinee may do better if he is not required to fixate.

All pilots and gunners are taught to scan and to use a roving gaze, although through force of habit the tendency is to fixate an object to see it clearly. Hence, an examinee who did not use his parafoveal vision although instructed to do so might fail the test, in which case his unsatisfactory night vision would be due to inattention and not to a defect in his visual apparatus.

Nevertheless, even though some individuals may be penalized, the advantages of permitting free movement of the eyes is believed to outweight the use of a fixation point. This is especially true if the examinees are given a practice test to demonstrate to themselves that in the dark-adapted state "off center vision" is better than direct vision. This can serve as a graphic proof of the increased sensitivity of the parafoveal retina.

The total *area of retina stimulated* necessarily depends to some extent on the nature of the test. In determining the visual threshold to a flash of light, Hecht[17, 18] advocated that the testing light subtend a visual angle of at least two degrees, this being large enough to give a uniform cross section of the retina. It was assumed, of course, that a fixation device would be employed. Godding[25a, b] favored using a seven-degree field without fixation, since threshold brightness is independent of area considerations in a test field of that size. However, if one is to measure visual *acuity* at scotopic levels of illumination, the size of the test object used will depend upon the level of illumination at which the test is to be conducted. This can be understood best by reference to Figure 2 which is adapted from some unpublished data (Hartline and McDonald).

Since visual acuity is dependent upon illumination,[28] a larger test object must be used if one is to test visual acuity at levels of illumination below that of a starlight night than if one were to test it at brightness levels between those of starlit and moonlit nights; conversely, a decrease in the size of the test object must necessarily be accompanied by an increase in the general level of illumination.

Thus, if a test letter subtending a visual angle of two degrees is used, it should be exposed on a test field subtending a visual angle of four degrees; otherwise the character will tend to fill up the field and clues other than visual acuity will come into play, that is, if a letter T subtending a visual angle of two degrees were exposed on a 3-degree

field, one could tell the position of the T by determining the darker side of the field; exposed on a 4-degree field this clue would be eliminated. Therefore, in a test of visual acuity, the area of retina stimulated will depend on the criteria established for the general level of illumination at which the test is to be conducted.

The *time of exposure of the test object* also depends on the nature of the test. Hecht[17, 18] advocated that, in the determination of flash thresholds, the duration of the flash be one-fifth second, since this is long enough to be well within the physiologic limits of the retinal reaction time. When a test object without a fixation spot is being used, longer exposures are necessary to obtain threshold readings.[25a, b] At low levels of illumination, exposure should be long enough for the examinee to be able to shift his gaze or try several areas of his parafoveal retina and yet not be long enough to induce fatigue. An exposure of 5 to 10 seconds should amply fulfill this requirement.

The source of *light* is one of the most important features of any test of visual function at low levels of illumination. Minor variations in the brightness of the light source at photopic levels are not of great importance, but in the measurement of the threshold of vision at scotopic levels such variations become of much greater significance. Hence, it must be insured that the light source is not subject to variations in intensity. This should be controlled by neutral density filters and not by varying the brightness of the light. The latter method would cause variations in the color temperature of the test light which in turn would give rise to the Purkinje phenomenon and affect the results of the test.

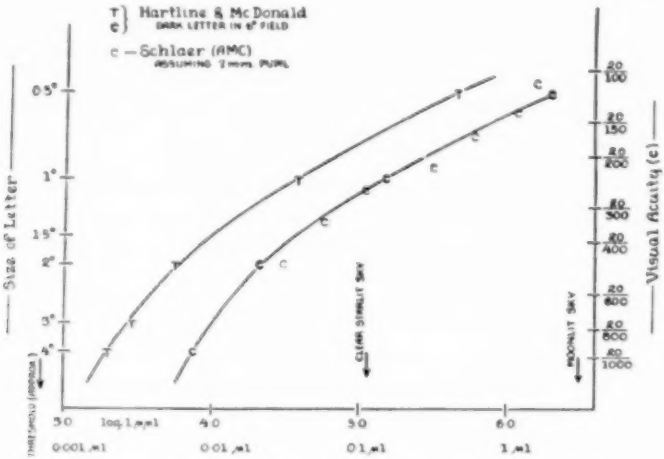

Fig. 2 (McDonald). A composite graph to show the relationship between visual acuity and illumination. The approximate brightness of the starlight and moonlight skies is also recorded. The size of the letter and visual acuity are plotted against the intensity which is recorded as the logarithm of the intensity expressed in micromicrolamberts and also in microlamberts.

In order to produce maximum stimulation of the rods a blue filter (480 μ) of constant density should be used in the path of the test light. This wave length produces maximum stimulation of the rods and also approximates the spectral characteristics of the night sky more closely than white light. The use of white light, however, would be quite satisfactory provided the same means of controlling the intensity were used.

Of the criteria mentioned for a satisfac-

tory test of dark adaptation, one can therefore omit a period of light adaptation, since the rate of adaptation is not under consideration and for practical purposes a period of 30 minutes' dark adaptation will insure a standard level for all examinees. Likewise, in an attempt to simulate operative conditions, the use of a fixation point to insure testing the same retinal area in all individuals can be omitted. A test of night visual capacity, therefore, resolves itself into a test of form discrimination at whatever level of illumination will most nearly approximate conditions under which night missions are performed.

The exact duplication of the specific conditions of night operations would require a fairly complicated test with many variables. Some compromise must, therefore, be made between comprehensiveness and practicability. Actually the visual task varies from the use of the threshold of vision to the discrimination of various size forms of varying contrast over the range of illumination of the night sky. The upper limits of these visual discriminations would necessarily involve some measurement of photopic acuity—such levels being reached on a moonlit night.

Since it is desired to measure scotopic acuity only, the level of illumination should therefore be restricted to that no higher than the starlit sky. At this level, however, one could devise a test in which the test object would vary in size and contrast (black to gray) and be presented on a white background, the brightness of which was kept within the desired limits. Such a test involves three variables and the more variables introduced the more difficult is the test to control. Wright[36] has devised a test of this nature. A series of Landolt C's, varying in brightness from white to gray, are exposed on a black background. The source of illumination is a plaque of luminous radium compound placed to one side of the test plate.

A simpler test would be to have either a test object of fairly large size and constant contrast which is viewed at varying levels of illumination well within the scotopic range, or to have test objects of varying size viewed at a fixed level of illumination also within the scotopic range. Measurements of dark adaptation[15, 21, 27] have shown that rod or scotopic vision covers a range of illumination of approximately 2.5 log $\mu\mu$ l (flash threshold) to 5.5 log $\mu\mu$ l.

Reference to Figure 2 shows that a Landolt C subtending a visual angle of four degrees (visual acuity 20/1000) can be seen at a level of illumination of approximately four log $\mu\mu$ l, whereas a similar letter subtending a visual angle of one degree (20/250) requires a level of illumination of approximately 5.2 log $\mu\mu$ l.

The recognition of the letters T or E subtending the same visual angle could be accomplished at lower levels of illumination since the visual task is somewhat easier. However, no matter what is used as a test object—airplane silhouette, boat, or other symbol—the correct visual angle can be determined if the levels of illumination at which it is desired to conduct the test are decided upon.

To recognize a test object subtending a visual angle of one degree or less requires a level of illumination at the borderline of scotopic and photopic vision. Many night operations are carried out at sky brightnesses varying between starlight and moonlight, but such a test is not one of rod vision. At these relatively higher levels of illumination, it is difficult to determine exactly what one is measuring. Visual tests below this level of illumination correlate fairly well with each other as do tests which involve predominantly cone vision. Tests which involve both rod and cone vision show very poor intercorrelation with tests of either rod or cone vision.

Test instruments

Most of the instruments described since 1939 embody some but not all of the criteria which have been described above; they all differ to some extent. Haines[38] described a simple instrument which provides for a

period of light adaptation after which the time taken to recognize the position of an arrow at some predetermined low level of illumination is recorded. As many readings as desired can be taken by resetting the intensity and one can therefore measure the change in threshold over a period of time. Yudkin[39] made some further improvements in the same instrument and used it for threshold measurements of a spot of light rather than of the recognition of an arrow.

Bishop Harman[22a, b] has described a simple test in which the examinee is required to recognize the number of discs on a black screen. There are four groups of discs, the number of discs varying in each group. The light source is a standard candle set at a predetermined distance. The examinee approaches the test screen until he answers correctly. This test has met with considerable criticism.[40]

The two most widely used tests in England during the war were those designed by Craik and by Livingston.[29a, b] The Craik test, described by Rycroft,[23] was known as the Pentagon test and was used by the British Army. It consisted essentially of a five-sided figure on each face of which was a letter V in different positions. The light source was within the instrument but the sides were so arranged that the intensity was different on each face. The candidate was scored on a basis of 5/5, 4/5, and so on.

The rotating hexagon described by Livingston[29a, b] was a much more elaborate instrument, designed to test six individuals simultaneously. On each face of the instrument there are 16 figures, crosses, silhouettes, letters, and so on. The test figures are exposed at different levels of illumination and the candidate scored on a basis of the number correct out of the 32 presentations. The figures are stated to subtend the same visual angle though they vary rather markedly in difficulty of recognition. Because of the mechanical nature of the test there are many places where errors could arise such as variations of intensity from panel to panel, from instrument to instrument, and so on. However, the principal criticism of the test is that raised by Godding[25a, b]: it is not a test of dark adaptation. Livingston designed it, however, as a test to determine night visual capacity, and even though other visual, psychologic, and training factors had to be considered, it probably served its purpose.

Both of these tests were concerned with measuring visual acuity at low levels of illumination. The size of the test object was kept constant but the illumination was varied. The only objection that might be raised is that the range of intensity, especially in the Craik test, was not broad enough to permit an adequate quantitative evaluation of the results.

Godding[25a] and Koch[30a, b] have also described instruments for testing the light sense. Both of these adhere strictly to the essential criteria for a satisfactory instrument. The Koch instrument was used by Michaelson[41] in testing army personnel and, contrary to the statements of most other military personnel, he believes that an instrument determining the minimum light threshold is of more value than one determining the minimum form threshold.

The Canadian Army and Air Force used some of the instruments designed by the English though they were chiefly concerned with night-vision training.[42] At the end of the training period the examinees were required to spot the direction of a black disc on a contrasting background, that is, was it vertical, right or left? The relative merits of night-vision training and night-vision testing are not pertinent to this discussion. The Canadian Navy[20] used a modification of the Hecht-Shlaer instrument. The only essential change was to make the instrument more compact and to permit binocular viewing of the test field. In their hands, this instrument proved satisfactory.

In this country there was just as much

diversity of opinion about the best instrument as elsewhere. The Army Air Corps had four different types of instruments to test night vision.[43a, b, c] The large instrument mentioned in the first part of this paper was designed to test large numbers of individuals at training centers, and to be as free of human error as possible. The test object was automatically presented five times at eight different levels of illumination in 1 of 8 positions. The exposure time of 10 seconds and the change in illumination were all automatically controlled. Six examinees were tested at one time. Each had in front of him a model of the test object, a letter C made out of plastic. They were required to turn the break in the C to correspond with that of the test object; the response was automatically recorded if correct. Although the more complicated the mechanical device the greater the chance for mechanical failure, the instrument definitely fulfilled a purpose.

The other three types of instruments available were of the so-called portable variety: the Hecht-Shlaer instrument as designed for the Canadian Navy and the night-vision testers of the School of Aviation Medicine, and the Aero Medical Laboratory.[43a, c] The School of Aviation Medicine night-vision tester required the recognition of a Landolt C subtending a visual angle of two degrees. The source of illumination was a plaque of self-luminous paint behind the test letter, the intensity being controlled with neutral density filters. The test was conducted at 12 inches. The Aero Medical Laboratory's night-vision tester was similar in principle. The source of illumination was radium salt in a moisture-proof cell. The test letter was also a Landolt C. The candidate was first tested at 11 feet from the instrument; if he did not get 4 out of 5 presentations he was moved up to 9, 7, or 5 feet. The results were recorded as the distance at which the examinee got 4 out of 5 presentations correctly.

The United States Navy[44] employed a test somewhat similar to the Aero Medical Laboratory's test. The source of illumination was a radium plaque. In front of it was the test letter. A fixation device was attached to the side of the instrument.

Thus the instruments in general use by the Armed Services had one thing in common, that is, the recognition of a form at a low level of illumination. Some of the silhouettes, as in Livingston's[29] instrument, were rather complicated and the criticism that this was not a test of dark adaptation would appear justified. In this country, a test of much simpler form discrimination was employed. The size of the letter was determined by experiment to be one which would test scotopic acuity below the level of a starlit night (fig. 2).

Probably the most important feature of any such test is the control of illumination of the test object. This can be either a light bulb or a luminous plaque of a radium compound. Both have advantages and certain disadvantages. A properly controlled light source with provisions to check its brightness periodically is probably the better of the two. Trained personnel and adequate equipment are needed to do this properly. The radium plaques have the disadvantages of deteriorating slightly in intensity and of being affected by exposure to light. However, if the proper precautions are taken, they prove to be quite satisfactory in the smaller types of instruments. They have the distinct advantage of not requiring elaborate devices to ensure constant brightness.

Test scoring

No matter how accurate or elaborate a test one may devise, the entire value of the test may be nullified by improper scoring. Unfortunately, many investigators have not paid sufficient attention to this aspect. Thus, in the routine laboratory or clinical tests of dark adaptation the usual method of determining the threshold is by the "method of limits," that is, starting with flashes that can-

not be seen, the intensity of the test light is increased in small fixed steps until a flash is reported as seen, the intensity is then reduced about 0.2 μ μ 1 and after a brief pause the flash is repeated. After 3 or 4 flashes two values are arrived at—one where the flash is seen and one where it is not. If there is not too great a difference between the two values, the intensity at which 2 out of 3 flashes are seen is called the threshold. This method is not too laborious and was employed by Solandt and Best[20] in testing a large group.

A more accurate method of determining threshold is by "frequency-of-seeing curve" (unpublished data, Hartline and McDonald). Knowing the approximate threshold, a specified number of flashes are given in random order at each of several intensities, approximately 0.10 log μ μ 1 apart. At the highest intensity the flashes should be seen on every presentation, and at the lowest, none; at the intermediate intensities, some are seen and others are not. The mean threshold is therefore somewhere between these intensities, theoretically at that intensity where one half the flashes are seen and one half are not.

The number of correct responses may be used to determine the actual mean threshold or they may be used as a score to differentiate individuals. If an individual sees 25 out of 40 presentations, he is obviously better than anyone who sees only 15 out of 40. (This method of measuring stimuli is fairly commonly used in psychophysical methods of measuring sensation.) It has one distinct advantage in that it lends itself to scoring a routine or semiautomatic test. This is the method employed with the American Army Air Force Night-Vision Tester.[43b] It would appear laborious for a manually operated test but actually it would not be if the test were set up correctly. In an instrument allowing four different positions of the test letter, the test object could be presented 12 or 16 times at 3 or 4 levels of illumination. The score of number correct would be easier to tabulate and would be more accurate than just reading the intensity or the distance at which 4 out of 5 presentations were called correctly. If a candidate did that on his first trial the tendency would be to record that as his score and not make any further examination.

It must be remembered that in any subjective test of this nature, there are many factors to be considered apart from the instrument. For many this test is an entirely new experience. In a desire to do well, some may forget to use the parafoveal retina. Others, trying to avoid certain types of duty, may deliberately fail the test.

One must also consider the individual giving the test. Hour after hour in a dark, poorly ventilated room may soon dampen his enthusiasm and result in carelessness and inattention. These and other intangible factors must all be evaluated.

Reliability and validity

Finally, in any test of visual function, it is important to know the reliability and validity of the test. As is to be expected, there was little opportunity to investigate this problem in time of stress. To say a test is reliable means that it must align individuals about the same way each time the test is given. This in turn depends primarily upon (1) the accuracy and standardization of the instrument, technique, procedure, and so on, and (2) the size of the intraindividual variation as compared with the interindividual variation in the population tested.

It has been shown in the group of 162 cadets that there is an interindividual variation of the visual threshold of one log unit. If each individual were to show a day-to-day variation of one log unit (intraindividual variation), the test could not be considered reliable since it could not align individuals in the same way at each test. This would not be a criticism of the instrument, but, in statistical terms, the test would not be reliable since in the visual function tested each individual

might vary as much as the whole group.

The two different tests of dark adaptation in this report show good test-retest reliability. The correlation between the two tests has not been made because these studies were carried out at different times and on different individuals. Since most of the different instruments described above were modified from instruments known to have good reliability, the authors have for the most part not retested large groups of individuals. Yudkin, and others,[21] reported that on retests of the same individual the final rod threshold varied by about 0.2 log units. This is in close agreement with my findings and those of Hecht and Mandelbaum.[18]

The validity of the test is the correlation of the results of the test with some measure of performance, that is, flying ability (accident rate, success or failure in flying training, enemy planes shot down at night, and so on). The validity will be low (1) if the function tested has little or no correlation with the test of flying, (2) if the test is not reliable due either to poor technique and instrumentation or to little difference in the intraindividual variation as compared to the interindividual variation, or (3) if the test scores do not have a high correlation with the critical function purportedly measured.

Unfortunately, there has been no validation of these tests against actual performance. This is true for most of our tests of visual function. In fact most of our physical standards have been established without any validation. Moreover, any one function we measure contributes such a small part to the actual performance of flying that its validation is extremely difficult.

Most of the studies on dark adaptation within the past few years have been concerned with factors that impair night vision. The role of vitamin A deficiency in causing impairment of night vision is now well established and it is well recognized that the response to vitamin A therapy varies from individual to individual.[14, 15, 18, 21] It has also been clearly shown[45] that there are various ocular conditions that may account for an abnormal rise in the visual threshold, and that there are also certain other physiologic factors that may cause such a rise. One of these is the deterioration of night vision with age[46, 47] which has been attributed to a decrease in the pupillary diameter. Anoxia has also been shown[48–51] to cause such a rise. This is believed to be brought about by the effect of anoxia on the central nervous system and not on the visual purple.

In any study of night vision, it would seem logical that an attempt be made to improve the visual threshold of normal individuals. Anything that might improve the transparency of the ocular media or increase the concentration of visual purple in the outer limits of the rods should improve night vision. Since there is no known means of improving the transparency of the ocular media, the first obvious approach was to attempt to improve the threshold by feeding large amounts of vitamin A in the hope that this might be reflected in an increase of this protein in the visual purple. In the experiment that was conducted there was no significant improvement in the visual threshold following eight weeks of vitamin-A therapy. This might be expected since the individuals in this age group were in perfect health and their threshold of vision approximated the absolute limit.[131]

Yudkin[52] has reported on the effect of vitamin A, alcohol ,and benzedrine on the final rod threshold. Most of his subjects, however, had thresholds that were considered abnormal. He found that 100,000 units of vitamin A caused an improvement in the threshold within 4 to 10 hours but by 24 hours the threshold had returned to its previous level. Alcohol and benzedrine both caused a transitory improvement of the threshold for 30 to 60 minutes but the effect was not noticeable after 90 minutes. Kekcheev,[53] in a paper that is poorly documented, states that caffeine, kola, and alcohol im-

prove night vision. He also states that stimulation of one sense organ increases the sensitivity of the other sense organs. Listed are stimulants to taste and smell that will improve night vision. In general he believes that pleasant sensations lower the threshold and unpleasant sensations raise the threshold. There is no other literature available to corroborate his claims.

Lythgoe[54] and Craik,[53] in papers that appear to be frequently overlooked, stress the fact that the mechanism of dark adaptation cannot be explained solely on the basis of the bleaching and regeneration of visual purple. Lythgoe believes that the increase in retinal sensitivity to light is brought about by both the regeneration of visual purple and some change in the neural mechanism of the retina. Since Yudkin[52] does not think that the effect of alcohol and benzedrine is brought about by a change in the vitamin-A content of the blood it is possible that these drugs may affect the neural component as proposed by Lythgoe.[54]

The search for some method to improve the visual threshold in normal individuals has not been very productive. In evaluating the effect of substances that affect the entire nervous system, that is, alcohol, anoxia, and so on, great caution must be paid to be certain that the results are accurate.

In some unreported experiments (Hartline and McDonald) on the effect of choline on the visual threshold it was found that in some instances trained individuals reported seeing many more blanks than usual. This might not have been noted except for the fact that the threshold was being measured by the frequency-of-seeing method and it was customary to give each individual a certain number of blank presentations. Unless this had been detected, it is quite probable that the true effect of the drug would have been missed.

Conclusions

Prior to World War II most of the investigative work on night vision was concerned with physiologic studies of the mechanism of vision or the effect of nutritional deficiencies on the visual process. This work fortunately provided the basic information needed for the tremendous problem of trying to evaluate and protect the night vision of those civilians and soldiers who were required to perform their various duties at night.

Since all physical examinations prior to the war were concerned only with tests at photopic levels of illumination, satisfactory tests at scotopic levels had to be devised. Of necessity some tests were devised and put into operation without much preliminary evaluation. Some sacrificed accuracy for simplicity though, for the most part, the tests were able to detect those who showed defective night vision. Practically all the tests developed during the war had one thing in common: they measured the threshold for form rather than that for light.

The introduction of a measure of visual acuity even at scotopic levels of illumination complicated the test. The criticism that such a test was not a test of scotopic vision was justified especially if the test objects were difficult to recognize or if they were so small (fig. 2) that to be recognized the level of illumination approached that of photopic vision. Most of the tests, especially the more elaborate ones, attempted to assess the examinees' night vision on a quantitative basis.

In the experiments that have been reported the tenfold variation in the final rod threshold of healthy young adults confirms the findings of other investigators. The two different night-vision tests employed, one a test of the visual threshold to a flash of light and the other the recognition of a 2-degree C, have both shown good reproducibility or test-retest reliability. It has also been shown that the visual threshold in normal individuals is not improved with large doses of vitamin A.

In discussing the improvement of the visual threshold, no mention was made of the various means used to protect the thres-

hold, that is, the use of goggles, red lights, developments in instrument panel illumination, the use of oxygen at night, and so on. These do not enter into a discussion of the evaluation of night vision.

The ideal of any test of night vision is that from the results one could eliminate the poor and select the best for special assignments that might involve night operations, and so on. As is frequently the case, the ideal is seldom achieved. If failure on the test means removal of the trainees from certain types of training, especially if such training is none too desirable, the elimination rates goes up once that fact becomes known. In subjective tests of this nature it is very easy to fool the examiner. Given sufficient retests and individual examination the true situation can frequently be uncovered but the excuse can always be given that the test was not understood.

As a means of selecting the best individuals for a particular job, the test is again none too satisfactory when employed on a large scale. There are so many other factors such as motivation, intellect, natural skill with a particular instrument or airplane, and others, that the performance score on a night-vision test is frequently overshadowed by other considerations.

Most of the individuals who complained of difficulty in performing their assigned duties at night were found to have normal night vision. (Such complaints are frequently the earliest manifestation of anxiety.) Despite this, however, it is believed that a test of night vision on all military personnel is worth while—some cases of night blindness are always discovered on routine examinations, especially in groups less highly selected than cadets. Also in the vast majority of individuals this test proves to be the first demonstration they have ever had that, at low levels of illumination, eccentric vision is many times better than central vision.

Like many tests of physical capacity it is no better than the person doing the testing. Given a satisfactory instrument and an interested examiner, a test of night vision becomes an important diagnostic aid as well as a means of demonstrating the important aspects of scotopic vision. However, until this one aspect of visual function is correlated with actual performance, no opinion can be expressed as to its value in a battery of tests for selection of individuals for flying duties.

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RIBOFLAVIN TREATMENT OF SPRING CATARRH

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In 1944, Castellanos[1] published a paper on his experiences with riboflavin in the treatment of spring catarrh (vernal conjunctivitis). He found that 92 percent of 105 patients improved within a short time (35.7 percent in 3 to 4 days and 65 percent in 10 to 15 days) when 1 to 3 mg. of riboflavin were given daily by mouth. During this treatment, the patients also received eyedrops containing adrenalin. He explained this favorable effect by assuming that riboflavin is rapidly destroyed in summer by the increased ultraviolet radiation, and concluded that spring catarrh is actually a riboflavin deficiency.

In a reply in the same journal, Lehrfeld[2] attacks this paper vigorously, denying that riboflavin can conceivably be of any use in the treatment of spring catarrh because this disease has been proved to be of allergic origin. Lehrfeld assumes that the improvement observed by Castellanos in his cases is solely due to the local treatment with adrenalin.

To treat patients with spring catarrh by administering a substance well known to give considerable relief in this condition while experimenting with a new therapeutic agent must be regarded as an inconclusive experimental set-up, and to claim full credit for riboflavin without considering that adrenalin might have had a share in the successful treatment is not justifiable. Moreover, the explanation offered by Castellano was not convincing. Riboflavin deficiency is a reasonably well-defined clinical picture, and to ascribe a condition to a lack of riboflavin because this substance gives relief can hardly be defended. Moreover, it seems that riboflavin is present in the cornea in its coenzymatic form which is light-stable.[3-5]

However, in view of recent observations on the antiallergic properties of several members of the vitamin-B complex, the idea of testing them on cases of spring catarrh seemed attractive, and the results of this investigation are to a certain degree a vindication of Castellano.

Investigation

Twenty-two cases of spring catarrh were treated. Of these, 13 presented the palpebral form of the disease, four of them showing only milky conjunctival edema while nine suffered from papillary hypertrophy giving the conjunctiva the typical cobblestone appearance.

Seven cases showed the bulbar form with hyperemia and edema of the bulbar conjunctiva and grayish gelatinous "epaulettes" encroaching upon the cornea to a varying degree. Two cases belonged to the so-called mixed form with involvement of the bulbar as well as the palpebral conjunctiva. In all cases, the history and subjective complaints were typical for the disease.

Results

The nine cases suffering from the palpebral form with papillary hypertrophy re-

ceived 5 mg. of riboflavin twice daily, three of them together with 25 mg. nicotinamide. They responded uniformly well. No other treatment was given during this time.

After the first few days, the subjective symptoms—burning, itching, and photophobia—improved considerably, and the pathologic changes of the palpebral conjunctiva receded to a varying degree, leaving the conjunctiva less hyperemic and smoother. The cobblestones were less marked, although they never disappeared altogether.

The improvement was not maintained when the treatment was discontinued. Riboflavin could be replaced by preparations containing the whole B complex (Betotal, Bevitex, yeast tablets) with satisfactory results, and the combination of riboflavin (5 mg.) and nicotinamide (25 mg.) twice daily seemed particularly effective.

The four cases of palpebral spring catarrh, without papillary hypertrophy but with milky edema only failed to derive any benefit from treatment with riboflavin by mouth or injections of the B complex.

One of the two cases with the mixed form improved somewhat with 3 gm. of yeast tablets daily, the second one did not respond to riboflavin, B complex, nor nicotinamide by mouth.

The same negative results were recorded in the seven cases with the bulbar form of spring catarrh.

Discussion

It is interesting, but cannot be explained at present, why the patients with the bulbar and mild palpebral form of spring catarrh failed to improve under a therapy which proved so beneficial to the cases with papillary hypertrophy (cobble-stones) of the palpebral conjunctiva. Further investigations will have to be made, and it is anticipated that some ideas may be derived from the results as to the peculiar fact that one and the same disease can produce so fundamentally different clinical pictures—if it really is one and the same disease.

An attempt will be made, however, to explain the results obtained in the light of recent knowledge of the antihistamine properties of riboflavin and nicotinamide, by assuming that it is a histamine sensitivity which constitutes the physiopathologic basis of the nosologic entity in the cases deriving benefit from the treatment described.

There can hardly be any doubt that spring catarrh is an allergic condition. Berens[6] and Gifford[7] are the exponents of a small number of authors who doubt this and do not admit allergy as the cause of it in every case. It seems, however, undeniable that a large amount of evidence points to the allergic nature of spring catarrh. The clinical picture with its recurrences; the climatic and seasonal incidence; the frequent association with other allergic conditions as asthma and hay fever; the absence of bacterial agents or inclusion bodies and the presence of eosinophilia; the frequent finding of a positive Prausnitz-Küstner reaction to specific allergens; the reaction of the conjunctiva to adrenalin—all these facts are, according to Lagrange and Delthil,[8] proof of the allergic nature of the condition.

The physiopathologic basis for allergic manifestations is an abnormal response of the capillary system to physical stimuli which causes a disturbance in the capillary circulation. This results in disorders of the cell nutrition, liberation of histamine in the tissue, and disturbances of the fluid and electrolyte metabolism. The manifestations are localized because they are transmitted by the parasympathetic nervous system, reactions of the sympathetic system only being generalized (Otfried Mueller).

Best and Taylor[9] summarize the present views in the following words: "It is now generally accepted that the antigen-antibody reaction in some way brings about the liberation of histamine by the affected tissues and that the action of this amine is re-

sponsible for the allergic manifestations."

Magitot[10] describes how the irritation of the subepithelial layers leads to follicle formation in the mucous membranes and points out that the participation of the nervous system in an inflammatory process consists of stimulation of the sensory nerve terminals, whereby histamine is liberated, resulting in vasodilatation.

Histamine and adrenalin are antagonistic in their effect upon the capillaries, and adrenalectomized animals show an increased susceptibility to histamine administration. This fact may be an explanation of the beneficial effect of adrenalin in spring catarrh. It does not simply act as vasoconstrictor, thus alleviating the symptoms, but, as an histamine antagonist, it exerts its therapeutic action on a more basic level as well.

A considerable number of antihistamine agents have been found recently. One of them is riboflavin. It is known that this vitamin plays a rôle in the dehydration and destruction of histamine. It is a component of a diamino-oxidase which is essential in this process.

This has been proved experimentally by Doxiades and Lemke[11] who could desensitize guinea pigs against an allergic shock by previous administration of riboflavin. Kalter[12] has treated asthma successfully with riboflavin and has also had some success in the treatment of hay fever.

It has been shown by Daĭnow[13] that nicotinamide also exerts a very beneficial influence on such allergic conditions as hay fever and asthma. In collaboration with Halpern,[14] he showed in animal experiments that guinea pigs can be protected from an asthma attack in an atmosphere containing histamine by premedicating them with nicotinamide. A similar attack of asthma provoked by acetylcholine cannot be prevented with nicotinamide. Halpern and Daĭnow conclude from this that nicotinamide possesses a specific antihistamine property.

The same authors[15] showed that nicotinamide prevents and even relieves the spastic contraction of the isolated uterus and intestine of guinea pigs suspended in a solution containing histamine. In similar spasms caused by acetylcholine or the hormone of the posterior lobe of the hypophysis, nicotinamide failed to be effective.

In view of these experiments and clinical trials, it seems undeniable that riboflavin and nicotinamide are to be regarded as antihistamine agents. It is not surprising, therefore, that these substances are very effective in alleviating the symptoms of certain forms of spring catarrh, which, as has been shown, must be regarded as an allergic condition due to histamine liberation in the tissue.

Theoretically, the effect of nicotinamide on allergic conditions can perhaps be regarded as due to its regulating action on the cell metabolism as a prosthetic element of the dehydrating enzymes (cozymase). Colldahl[16] has shown that in experimental asthma of guinea pigs the lack of cozymase leads to a reduction of oxidative processes in the tissues which can be normalized again by administering this enzyme.

One can assume that histamine is not the only body responsible for allergic reactions and that other substances (acetylcholine, and so forth) also play a rôle. This may explain the fact that not all cases of palpebral spring catarrh were benefited alike from the administration of riboflavin by mouth, that the bulbar form did not respond at all. There must and will always be allergic conditions which will fail to respond to riboflavin or nicotinamide.

Moreover, one must always keep in mind that the therapy with antihistamine agents is a symptomatic therapy which does not remove the underlying cause for the allergic reaction but only alleviates its symptoms. Active antiallergic procedures, such as isolation from the guilty allergen or desensitization against it will remain paramount in the therapy of spring catarrh.

If and when isolation and desensitization

are not possible, however, we can regard riboflavin and nicotinamide as valuable allies in the symptomatic treatment of this annoying and sometimes even incapacitating disease.

3 Hopper Street.

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Ophthalmic Miniature

The ophthalmoscope was discovered by Hermann von Helmholtz in December, 1850, and the account thereof was published in the following year. In speaking of this invention some years later, he said:

"The ophthalmoscope has become the most popular, perhaps, of my scientific achievements, but I have already told the ophthalmologists how luck played an incomparably greater part than my merit in this matter. I had to explain to my students the theory of ocular luminosity, which stemmed from Brücke. Actually, Brücke had missed the discovery of the ophthalmoscope by a hair's breadth. He had only neglected to ask himself the question: To which optical image do the rays returning from the luminous eye belong? Had he raised this question, he could have answered it just as quickly as I did, and the ophthalmoscope would have been discovered. . . . I immediately set about to construct the instrument out of spectacle lenses and cover glasses for microscopic preparations. At first it was quite difficult to use, and without a firm theoretical conviction that it must work, I would perhaps not have persevered in my efforts. But after about eight days I had the great pleasure of being the first to see clearly a living human retina."

THE REACTION OF VARIOUS TYPES OF FAT TRANSPLANTED INTO THE ORBIT OF GUINEA PIGS PRIOR TO THE DEVELOPMENT OF EXOPHTHALMOS*

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Thyroidectomized guinea pigs receiving daily injections of extracts of anterior hypophysis develop exophthalmos which is accompanied by swelling and edema of the orbital and some fat tissues. These changes have been reported by several observers.[1-4] The edema, although noted in fat tissues other than in the orbit, is more marked there than in other regions such as in the perirenal or testicular fat bodies.[5] The reason for this difference is not clear and is of interest because of the importance of the role the edema may play in the production of the exophthalmos.

The edema of the orbit may be a local manifestation due to anatomic peculiarities of that region or, as suggested by Gailli Mainini,[6] a result of reduction in tissue pressure occasioned by the forward movement of the globe. If this concept is correct, the edema found in these animals should be restricted to the orbit, which, as has been shown, is not the case. Conditions in the orbit may simply exaggerate a generalized condition due either to factors as suggested by Gailli Mainini, or inadequate lymphatic drainage, and so forth.

Another possibility, which is in agreement with the available data, is that the permeability of the vascular bed varies with the tissue which it supplies, and that the vessels are not very permeable in these animals in the testicular, axillary, or perirenal fat but are in the orbital fat, as well as in the fat depots near the Fallopian tubes or the ureter.

These several concepts may be tested by transplanting fat from various parts of the body to the orbit and then producing an exophthalmos by the injection of anterior pituitary extracts. The histologic structure of the orbital fat of the intact and operated orbits could be compared with that of the graft and with donor type of fat tissue in its normal location.

If the transplanted tissue retained the characteristics shown in its original position, it would indicate that purely local orbital conditions were negligible in the production of the changes seen in the orbital fat of exophthalmic guinea pigs. If, on the contrary, transplanted fat were affected in the same manner as orbital fat, the importance of local factors would be emphasized. It was necessary, of course, to determine whether transplantation alone affected the response of the tissue to the injected extracts. Therefore, grafts of orbital fat were also made using as donors the male parent of the recipient.

EXPERIMENTAL

Forty-nine guinea pigs of both sexes were used in these studies. In seven cases, transplantation of fat to the orbit was done when the guinea pigs were young adults, in all others the grafts were made in 1- or 2-day-old animals. The Harderian gland which occupies a large space in the orbit was removed from the right orbit through a small conjunctival incision on the nasal side of the globe where its ducts open. The gland could be withdrawn from the orbit through this opening with a minimum of trauma and no bleeding save when the vessel to the gland itself was severed. The donor fat tissue was obtained from the same individual at this time and placed in the orbit. The con-

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junctival incision did not require sutures.

Donor tissue was taken from the right axilla in nine cases, the right testis fat body in 13 cases, the right ovario-uterine mesentery in 10 cases. Seventeen grafts of orbital fat were made in the same manner excepting that the transplants were from another, although related individual, rather than from the same animal.

The guinea pigs were thyroidectomized when several months of age and 7 to 10 days later daily injections of an anterior pituitary extract were administered to 39 of the animals. Representatives of each type of transplant, totaling 10 animals, were reserved as uninjected controls. The preparation and amount of extract administered was the same as reported in previous communications.[7, 8]

The length of the injection period varied widely; in some cases treatment was continued for 55 to 76 days. Eight animals, however, were injected for only 10 days. Each type of graft was represented in both long and short injection groups. Exophthalmos, as judged by inspection and postmortem measurement of the unoperated left eye, was present at the conclusion of the experiment.

At autopsy the fat in the operated orbit was carefully examined to determine if two (donor and host) zones could be distinguished, the tissue was then fixed in Bouin's fluid and histologic sections were prepared. The block of embedded tissue was oriented so that the sections passed through both the host and transplanted portions and showed the interface between the two.

The removal of the Harderian gland and transplantation of fat in its place resulted in a variable displacement of the globe inward and slightly downward. The injection of the anterior pituitary extract caused an exophthalmos which was evident in the intact left side. Protrusion of the operated right eye was not as marked as that of the intact left eye and exact measurements of the exophthalmos (skull-limbus distance) made postmortem were not as dependable as usual, because of the displacement of the globe caused by the operation. However, the operated right eyes averaged 0.5 to 0.6 mm. greater protrusion postmortem than their controls.

All of the autotransplants were well incorporated in the orbit and had greatly increased in weight since grafting. Their growth was demonstrated in a few instances by comparison of the weight of the donor tissue at the time of transplantation with that obtained at autopsy.

The orbital fat of exophthalmic animals has a translucent appearance due to edema which differentiates it very sharply from the normal, dense, opaque character of ordinary fat tissue. This appearance was also characteristic of the native orbital fat in operated

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Figs. 1 to 6 (Smelser and Ozanics). (Fig. 1). Section of orbital fat from an unoperated orbit of an exophthalmic guinea pig showing the edematous character of the tissue.

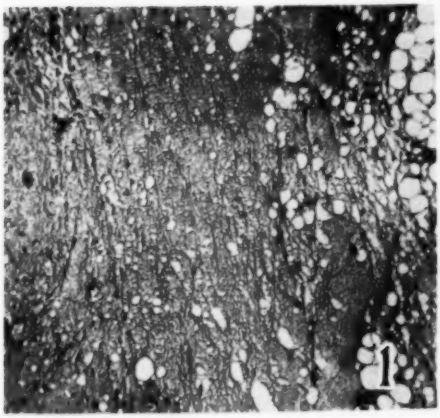
(Fig. 2). Section of transplanted orbital fat of an exophthalmic guinea pig. The graft had been made at birth and was from a related normal adult.

(Fig. 3). Section of orbital content of an exophthalmic guinea pig showing the interface between the edematous host orbital fat and the testicular fat transplant which remained unchanged by the pituitary extract injections and the development of exophthalmos.

(Fig. 4). Section of testicular fat in situ of an exophthalmic animal showing a region including some epididymal tubules. Note the presence of edema in the connective tissue surrounding the tubules and its absence in the purely adipose tissue.

(Fig. 5). Low magnification of a section through the orbital fat and graft of testicular fat of an exophthalmic guinea pig showing both the host and donor regions. Note that the host portion is edematous, whereas the grafted portion is not, except in the region of grafted epididymal tubules where edema is found. The situation is similar to that shown in Figure 4 where edema is noted near the epididymal tubules in testis fat in its normal location.

(Fig. 6). High-power view of the epididymal tubule region included in the graft shown in Figure 5.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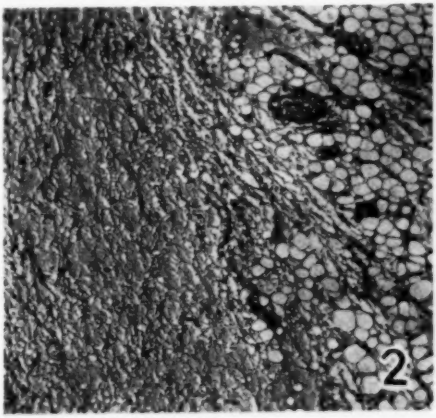
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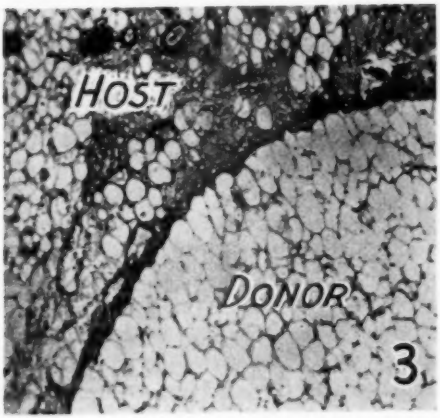
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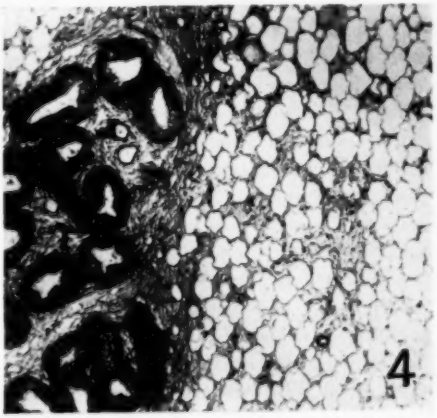
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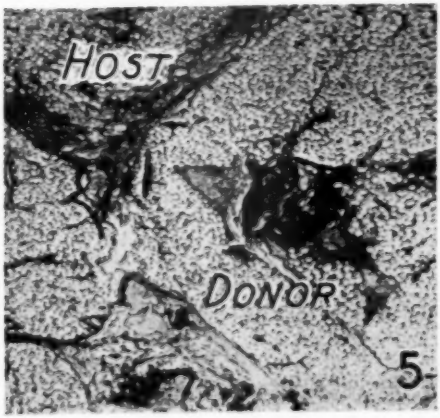
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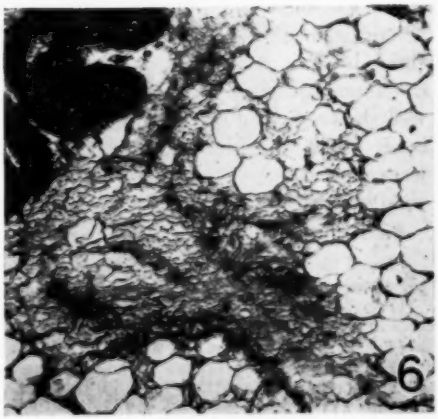
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orbits of the exophthalmic animals and contrasted sharply with the transplanted tissue of axillary, testicular, or uterine origin. Specimens of these donor-type fat tissues were removed from the appropriate regions, but from the side opposite that from which the fat used in making the graft had been removed. The orbital and transplanted fats of the 10 uninjected, control animals maintained the appearance of these tissues as observed in other thyroidectomized guinea pigs with intact orbits.

Gross observations of the orbits to which orbital fat had been transplanted did not reveal distinct separation of the fat into zones different in appearance or texture, and the entire mass appeared to be edematous. In a few instances it is possible that the major part, at least, of the graft had degenerated. This was indicated by a mass of dense connective tissue in the region where the implant had been made. In the other cases, however, the size of the homogeneous mass of fat in the orbit in the region of the graft together with the absence of scar tissue indicates that these transplants were well incorporated, and that the transplanted portion reacted to the injected pituitary hormone as did the original fat tissue of the host.

Sections were prepared of all the grafts as well as the orbital fat from the intact orbit and a specimen of the donor tissue. These where stained with Masson's trichromic stain, because with this stain the protein containing edematous infiltrate is particularly well shown. Sections of orbital fat from the intact orbits showed marked edema such as was reported earlier. Sections of the fat from right orbits which had been recipients of orbital fat grafts showed two zones, both edematous. They were separated by a line of connective tissue forming an interface between graft and host. The histologic character of the two zones was similar and like the orbital fat in the unoperated orbits of the same animals (figures 1 and 2).

This condition was not found to apply in the case of the orbits containing grafts of axillary fat or in some cases from the testicular fat body or fat from the uterine mesentery. In these cases two distinct zones of fat tissue of different character were observed (figs. 3, 7, and 11). One was, in each case, typical orbital fat and the other was a mass of adipose tissue composed of solid masses of fat cells separated by a few delicate strands of connective tissue, characteristic of the fat depots from which they came (figs. 8, 9, and 10). The two masses of fat were separated by a band of connective tissue, as were the host and graft of orbital fat. In several cases the graft appeared to have been pushed into the host tissue and was partly surrounded by a narrow zone of edematous connective tissue, presumably of host origin.

Most of the grafts of testicular fat (13 cases) behaved exactly as did those of uterine mesentery or of axillary origin. Two types of fat were seen in these orbits, one edematous and containing nerves, vessels, and muscle fibers (retractor bulbi) characteristic of orbital fat, the other one not edematous but consisting of masses of closely packed fat cells containing a few strands of connective tissue (fig. 3). Sections of the fat from the testes of these animals did not exhibit evidence of the edematous infiltration,

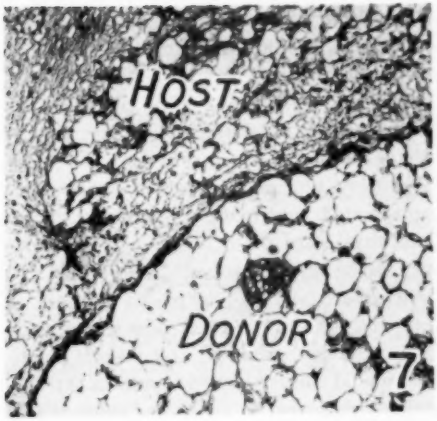
Figs. 7 to 11 (Smelser and Ozanics). (Fig. 7). Section of orbital content of an exophthalmic guinea pig showing the interface between the edematous host orbital fat and the unaffected graft of axillary fat.

(Fig. 8). Section of fat from the axillary region of an exophthalmic animal. Note absence of edema even in the connective-tissue band.

(Fig. 9). Section of edematous orbital fat from the host zone shown in Figure 7.

(Fig. 10). Section through the transplanted axillary fat from the donor zone shown in Figure 7. Compare this tissue with the axillary fat in situ shown in Figure 8.

(Fig. 11). Low magnification of the orbital contents of an exophthalmic guinea pig showing the edematous native orbital fat and the unaffected grafted fat taken from the axilla.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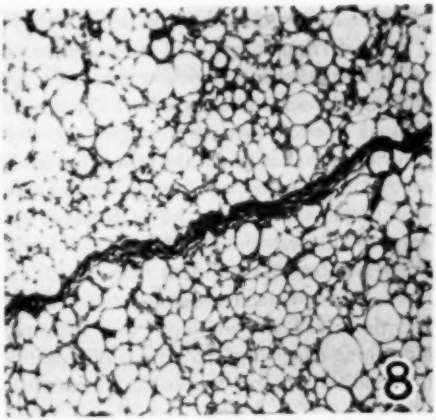
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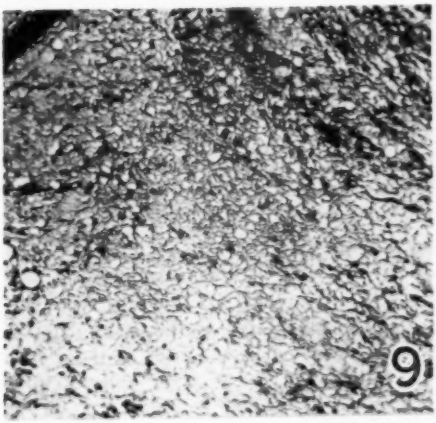
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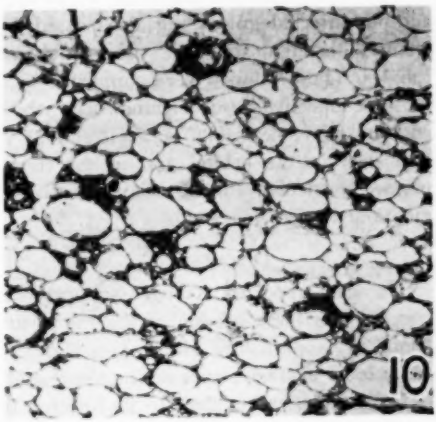
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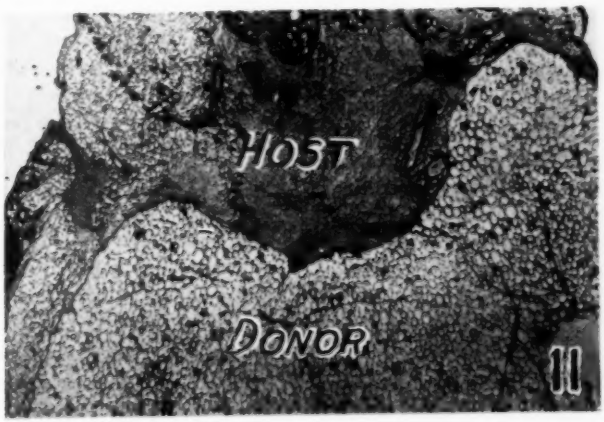
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with one exception, discussed later.

The fat from one orbit of an exophthalmic animal containing a testicular fat graft was not entirely similar to the others. The transplanted portion consisted largely of solid nonedematous fat as did the others but in the center of this mass, apparently unconnected with the host orbital fat, was a group of epididymal tubules which had been taken with the transplant by accident (fig. 5). They lay in loose connective-tissue network which was distended and infiltered with a protein containing edematous material similar in texture and staining reaction to the edema of the orbital fat (fig. 6).

Sections of one testicular fat in situ of another injected guinea pig also passed, by chance, through some of the epididymal tubules. These tubules were supported by a loose connective-tissue framework which contained an edematous material similar to that seen in the orbital and in the transplanted testicular fat of the case already mentioned (fig. 4).

Discussion

The data reported strongly supports the concept that the condition of the fat tissues found in exophthalmic guinea pigs is due to some basic characteristics of the tissue and/or its vessels, rather than to its location or the peculiarities of its site, such as lymphatic drainage. Since the transplants of orbital fat to the orbit reacted exactly as did native fat in both operated and intact orbits, it would appear that the act of transplantation did not interfere with the changes brought about by injection of the extracts. The transplanted tissues of all types maintained themselves and grew, rather than were replaced by growth of the host tissue, because two distinct masses of fat were found separated by a band of connective tissue.

In a few instances, not included in the reported cases, a graft of orbital fat obviously did not persist. In such cases the orbit contained some, presumably, native fat and a mass of scar tissue located in the region of the orbit where the transplant had been made. The orbital fat found was situated within the muscle cone and was traversed by the retractor bulbi muscles and ciliary nerves in the manner characteristic of the normal orbital fat.

Axillary, uterine, and testicular fats were transplanted under more favorable conditions than were the orbital fat grafts since they were autotransplants. All were well incorporated and had increased in mass in the orbit, but were unaffected by the injected extracts. They remained in a normal condition, as did the fat of their types in the normal environment. In an earlier study it was reported that fat in the axilla was not changed in a manner similar to that noted in the orbit. Fat from the region near the Fallopian tubes, however, was affected, indicating that the edema produced by injection of anterior pituitary extracts was not limited to the orbit, but was found in some other tissues and was absent, or very scant, in others. This observation was confirmed in the present experiments.

Dobyns's[9] report that testicular fat was modified in similar experiments performed by him is in essential agreement with cases reported here, for, although in most instances the sections of testicular fat studied showed no structural change from normal, they were only through that portion of the testicular fat body which contained very few connective-tissue septa and no epididymal tubules.

Obviously edema does occur in at least a restricted portion of the testicular fat of the experimental animals. This observation emphasizes the conclusion reached in the study of the other facts, namely, that transplanted tissues behave in the orbit in the same manner as they do in their native environment. Grafts of the nonreacting part of testicular fat were unaffected in the orbit by the injected extracts; whereas, that portion which became edematous in the scrotum also became edematous in the orbit.

Summary

1. The injection of anterior pituitary extracts into thyroidectomized guinea pigs produces an exophthalmos and an edematous condition of the orbital and some other fat tissues.

2. Orbital fat which has been transplanted to the orbit is affected in the same manner as the native orbital fat.

3. Fat which is unaffected in its normal location by the injection of anterior pituitary extracts retains this characteristic when transplanted to the orbit, although the grafts are well incorporated and have increased in size.

4. Fat tissue which is affected in the pituitary-extract treated animals also becomes edematous when transplanted to the orbit of appropriately treated animals.

5. These data are interpreted to suggest that the edema of the orbital and other fats caused by the pituitary extracts is due to conditions peculiar to those tissues and their vascular supply, rather than to their location in the body.

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Ophthalmic Miniature

In no subject were the Greeks less independent than in the pharmacology of the eye. They took a formidable list chiefly of inorganic compounds over from the Egyptians. The list contains antimony, alum, saltpeter, lapis lazuli, and half a dozen others.

Hirschberg, *Graefe-Saemisch Handbuch.*

LEPTOSPIRAL UVEITIS*

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Of the many pathologic conditions which are known to give rise to disease of the uveal tract, one of the more rarely encountered and less frequently recognized is Weil's disease or Leptospirosis icterohemorrhagica, only 222 cases of which have been reported in the United States literature.[1]

Weil's disease is an acute systemic infection. The etiologic agent is the Leptospira icterohemorrahgicae, a spirochete found commonly in rats, and less frequently in dogs, mice, cats, and other animals. Human infection usually occurs from contact with stagnant waters contaminated by murine excreta, the portal of entry usually being the abraded skin, although infection may occur by way of the gastro-intestinal tract, the nasal mucosa, or the conjunctiva. The disease is especially prevalent in those working in rat-infested environments: sewer workers, fish and poultry handlers, miners, butchers, tunnel diggers, and so forth. Clinically the disease is characterized by a sudden onset with headache, fever, prostration, and myalgia. In the more severe cases, jaundice occurs, and hemorrhagic phenomena and evidences of renal impairment are present. In the milder and anicteric cases, diagnosis may be difficult, and it is undoubted that many go unrecognized.

Diagnosis may be definitely established by the isolation of the causative organism from the blood or urine, and by the demonstration of specific lysins and agglutinins in the serum. A positive agglutination in a titer of 1:300 or above[2, 3] or a complement fixation titer of two units or more[4] is considered diagnostic of Weil's disease. Death is extremely rare in the anicteric cases, but the fatality rate in some epidemics of Weil's disease has been as high as 30 to 48 percent.[2, 3] Penicillin is a specific therapeutic agent. Streptomycin and aureomycin are also drugs of value in this condition.

The eyes are commonly involved in Weil's disease. Early in the course of the illness conjunctival injection is the rule.[2, 3, 5-8] In some cases a catarrhal conjunctivitis[6] and petechial hemorrahges in the conjunctivas[3] may be present. Patterson[9] found conjunctivitis and episcleritis in every one of a series of 37 cases of Weil's disease which he studied. A mild form of iritis or iridocyclitis frequently occurs late in the disease, appearing between the 16th and the 42nd day.[5] The frequency with which the anterior uveal tract is affected is variously reported at from 3 percent[7] to 44 percent.[5, 8] Hypopyon has been noted.[7] The posterior uveal tract is rarely involved.[6] The retina may show congestion and small hemorrhages, and occasionally optic neuritis may occur.[6] Orbital pain due to involvement of the extraocular muscles is occasionally present.[10]

CASE REPORT

Because of the uncommonness of established cases of Weil's disease in this country, and the unusual features of a case which was recently seen, the following case report is presented.

History. C. S., a 26-year-old Negro, was admitted on September 27, 1947, to the ophthalmologic service of Dr. James S. Shipman at the Wills Hospital with the chief complaints of some blurring of vision and the presence of streaks and spots in the fields of vision in both eyes. He stated that he was well until a month previously, when he de-

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veloped fever, sweating, chills, headache, generalized malaise, and anorexia, his temperature going up as high as 102°F. After a week of pyrexia, his fever subsided and he noted jaundice. Two weeks later, while his jaundice was still present, his eye complaints began. He was afebrile after the first week of his illness.

Physical examination on admission revealed a well-nourished, young Negro in no acute distress. There was no fever. A moderate degree of conjunctival icterus was noted. The lungs were clear, and the heart showed no abnormalities of note. The liver edge was palpable one-finger's breadth below the right costal border and the spleen was not demonstrably enlarged. No hemorrhagic phenomena were noted.

The vision was: O.D., 6/60; O.S., 6/21. Both pupils were dilated and fixed, and there were numerous keratic precipitates of various sizes on the posterior surface of both corneas. A positive flare and some small pigmentary changes on the anterior and posterior lens surfaces were noted. Because of the presence of numerous thready, floating, vitreous opacities, the details of the fundus could not be well visualized.

The hemogram revealed an erythrocyte count of 3.02 millions with a hemoglobin of 62 percent and a total leukocyte count of 7,100, with 63 percent mature polymorphonuclear leukocytes, 3 percent stab forms, 8 percent eosinophiles, and 24 percent lymphocytes. The color index was 1.0. No sickling of the red blood cells was seen. The fasting blood sugar was 71 mg. precent, and the serum bilirubin was 1.0 mg. percent with a delayed direct reaction.

The prothrombin index by the simple bedside test was 63 percent, and the cephalin flocculation was plus 2 at the end of 48 hours. The sedimentation rate by the Westergren method was 25 mm. per hour. The agglutination reaction for B. abortus was negative. The erythrocyte fragility revealed that hemolysis began at 0.42 and was incomplete at 0.28.

The Wassermann reaction and the intradermal Mantoux test were negative, and a prostatic smear showed no evidence of infection. X-ray examination of the chest revealed no evidences of any active pulmonary disease. Slight mucosal hypertrophy of the left ethmoid cells was noted on X-ray study of the nasal accessory sinuses. No evidences of dental infection were found on roentgen examination. Otorhinolaryngologic consultation revealed only deviation of the nasal septum and minimal tonsillar disease.

Course in hospital. It was felt upon admission that the patient's jaundice resulted from a subsiding infectious hepatitis and, as a consequence, fever therapy was felt to be contraindicated. He was treated conservatively for his eye disease with atropine, and for his suspected liver disease he was placed on a high carbohydrate, high protein, low fat diet with multivitamins.

He was afebrile during the course of his hospital stay except for a mild temperature rise during his first hospital day as a result of an initial dose of typhoid vaccine which was administered on admission. The jaundice gradually disappeared and satisfactory recovery of vision and clearing of the media occurred.

The patient was discharged from the hospital on October 10, 1947, with vision with pinholes of: O.D., 6/15—1; O.S., 6/12—2.

He returned to the medical clinic on October 22, 1947, at which time no icterus was discernible and the liver and spleen were not palpable. A bromsulfalein determination showed a retention of less than 5 percent with the 2 mg. dose after 30 minutes, and the serum bilirubin was 0.3 mg. percent.

Serologic studies. Questioning at this time elicited the information that until the onset of his acute febrile illness, the patient had been working as a member of a construction gang engaged in the tearing out of an old sewer and the installation of a new one. Because of this occupational history, it was suspected that the illness from which the patient had recovered might have been a leptospiral infection.

Serologic studies at the Graduate Hospital, Philadelphia, revealed a positive agglutination in a dilution of 1:1,000* and a complement fixation titer of 3.75 units for the Leptospira icterohemorrhagicae, both strongly positive reactions. The cephalin flocculation at this time was negative after 48 hours, and the hemogram revealed an erythrocyte count of 4.31 millions with a hemoglobin of 72 percent and a total leukocyte count of 10,300 with 76 percent polymorphonuclears, 5 percent eosinophiles, 2 percent basophiles, and 17 percent lymphocytes.

Iridocyclitis. The patient's ocular condition continued to improve on his periodic visits to the eye clinic, and the vision on December 26, 1947, was 6/9 + 2 in either eye. On February 10, 1948, however, an acute iridocyclitis recurred in the left eye. He was readmitted to the hospital the same day with vision of: O.D., 6/9; O.S., 5/60.

Examination revealed the presence of numerous punctate keratic deposits in the left eye. There was marked turbidity of the aqueous and numerous cells were present in the anterior chamber. The vitreous contained large varishaped opacities. Central visual fields in the left eye showed a quadrantlike cut in the upper temporal area with a 1-mm. test object.

Additional serologic studies at this time revealed a positive agglutination in a dilution of 1:1,000* and a complement fixation titer of 4.5 units for the Leptospira icterohemorrhagicae. A course of penicillin therapy totalling 5,000,000 units given at 3-hour intervals over a period of 12 days was administered, and the patient's uveitis became quiescent. He was discharged from the hospital on February 23, 1948, with visual acuities of: O.D., 6/6; O.S., 6/12.

The patient's progress was followed periodically in the out-patient clinic. When he was last seen on May 28, 1948, there was no injection of either eye. Both irides were active and free of synechias. Very few keratic deposits were present. No anterior chamber abnormalities could be found, and the vision in each eye was 6/6.

Comment

The case reported above represents an instance of a mild case of Weil's disease complicated by a bilateral iridocyclitis with some evidence of posterior uveal involvement. The eye findings dominated the clinical picture and constituted the presenting complaint which brought the patient to seek admission in an eye hospital. It is of interest that the patient's occupational history furnished the clue to the diagnosis.

The diagnosis of Weil's disease rests upon a high index of suspicion. The possibility of Weil's disease should be thought of by the ophthalmologist in any patient with iritis or iridocyclitis accompanied by or preceded by fever or jaundice, particularly in those patients whose occupations bring them into contact with rat-infested surroundings.

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* The agglutionation reaction was not carried beyond a dilution of 1:1,000.

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LIMITS OF STEREOPSIS DUE TO PHYSIOLOGIC DIPLOPIA*

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In the ordinary two-line tests for stereopsis, the ability of the subject to detect the difference in distance of the lines from the eyes increases indefinitely with the increasing nearness of one line. Obviously, at some point, physiologic diplopia occurs, just as a spot on the window pane appears double when one observes a tree outside, and the tree appears double when one observes the spot. One is not commonly conscious of physiologic diplopia because of suppression of one of the two retinal images.

Does physiologic diplopia interfere with stereopsis? There has been to date no evidence that it does. A crossed physiologic diplopia, where the left image is seen by the right eye and the right image is seen by the left eye, has been believed to produce a strong binocular clue for nearness. An uncrossed diplopia was believed to produce a clue for farness.

This paper presents experimental set-ups where more than a certain amount of difference in the distance of vertical line targets from the eyes causes a deterioration of depth judgment. The evidence suggests that imperceptible degrees of physiologic diplopia are enough to interfere with stereopsis.

This new phenomenon is interesting to ophthalmologists for several reasons: It gives evidence on the extent of Panum's fusional areas. It adds a new factor to consider in devising instruments to test steropsis. It helps to explain difficulties some patients have at first with the space eikonometer, which is a rapid test for stereopsis on line targets. It will modify the technique used in testing aniseikonic patients.

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EXPERIMENTAL TECHNIQUES

EXPERIMENT I

In the summer of 1946, A. Ames, Jr., of the Dartmouth Eye Institute devised a new target for testing patients with aniseikonia which he asked me to try on patients already tested with other instruments. This target, illustrated in Figure 1, consisted of luminous rectilinear grids placed at eye level 14 feet from the eyes. These grids, made on black-painted glass by scratched lines, were placed on a box containing fluorescent lamps. The

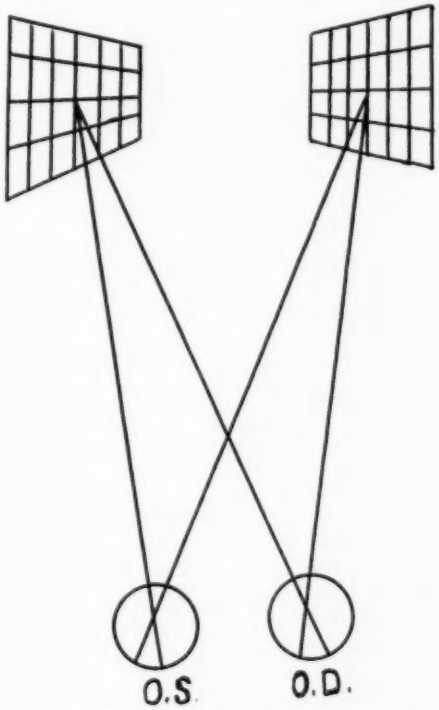

Fig. 1 (Miles). Rectilinear luminous grid targets, devised by A. Ames, Jr., for measuring aniseikonia which showed defective stereopsis with increasing physiologic diplopia.

grids measured 16 by 24 inches, and were mounted face to face 8 feet apart.

The patient was placed with head fixed in position as indicated in Figure 1, in complete darkness, with his refractive prescription before his eyes. He was asked to look from one of the grids to the other and report which appeared nearer. Then the two grids were equated by placing, by hand, size lenses (axis-90°, magnifying afocal lenses) before the eye on the side where the grid appeared nearer. Then, the sensitivity of the patient was determined by finding the smallest size lens which would make a perceptible difference in distance of the two grid targets.

Twenty-four known aniseikonic patients were tested in this way. Four were insensitive, and the others were highly sensitive to small size lenses, but insensitive to size lenses magnifying more than 0.75 percent. The conclusion was that the target was more sensitive than the space eikonometer target to small differences in magnification, but that something destroyed sensitivity when the magnification exceeded 0.75 percent. Patients were unable to localize the targets in space until their size prescription, within about 0.75 percent, was placed before their eyes. At the time, it was believed that the difficulty was due to one grid geometrically approaching the patient's face absurdly near, causing the patient to discard binocular clues.

TABLE 1

RESULTS OF 112 JUDGMENTS AS TO POSITION OF THE TWO TARGET LINES EXPOSED IN RANDOM ORDER IN SEVEN DIFFERENT POSITIONS. NOTE THAT JUDGMENT IS BETTER WHEN THE DIFFERENCES IN TARGET LINE DISTANCE TO THE EYES ARE SMALL, AND DEFECTIVE WHEN GREATEST

Actual target line position, 64 mm. P.D.	Right 3 cm. Near −3		Right 2 cm. Near −2		Right 1 cm. Near −1		Even 0		Left 1 cm. Near +1		Left 2 cm. Near +2		Left 3 cm. Near +3		Sensitivity at 75% Correct
Experimental near judgments	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	
1. M. B., stenographer, 62 P.D.	8	8	5	11	4	11	8	8	12	4	11	5	8	8	10 mm.
(Dark adapted)	11	5	5	11	6	10	9	7	12	4	10	6	12	4	18 mm.
2. J. A., maid, 60 P.D.	4	12	3	13	12	4	10	6	11	5	13	3	12	4	6 mm.
(Dark adapted)	2	14	3	13	12	4	14	2	14	2	15	1	14	2	5 mm.
3. M. M., housewife, 62 P.D.	1	15	0	16	1	15	9	7	12	4	14	2	12	4	5 mm.
4. J. S., M.D., 62 P.D.	2	14	4	12	5	11	11	5	16	0	16	0	14	2	10 mm.
5. M. L., nurse, 62 P.D.	0	16	0	16	0	16	4	12	13	3	14	2	13	3	5 mm.
6. D. F., M.D., 64 P.D.	1	15	3	13	1	15	7	9	13	3	15	1	16	0	5 mm.
7. R. R., student, 62 P.D.	1	15	2	14	2	14	4	12	9	7	15	1	11	5	7 mm.
8. R. P., M.D., 60 P.D.	3	13	2	14	3	13	13	3	14	2	16	0	15	1	8 mm.
9. E. D., M.D., 68 P.D.	0	16	0	16	2	14	10	6	15	1	16	0	16	0	5 mm.
10. E. G., M.D., 62 P.D.	7	9	7	9	6	10	7	9	10	6	10	6	7	9	?
11. U. L., M.D., 60 P.D.	0	16	1	15	2	14	2	14	7	10	15	1	16	0	6 mm.
12. K. O., M.D., 60 P.D.	5	11	5	11	7	9	8	8	10	6	13	3	16	0	20 mm.
13. B. T., M.D., 66 P.D.	10	6	10	6	9	7	10	6	8	8	12	4	13	3	?
14. Y. T., M.D., 66 P.D.	5	11	2	14	3	13	6	10	13	3	16	0	15	1	11 mm.

EXPERIMENT II

The present experiment began as a study of stereopsis in the dark-adapted individual. When the first subject showed excellent stereopsis on a two-line test at 2 meters with one line moved back and forth 2 cm., but none at all when the line was moved 3 cm., it was realized that the same phenomenon elicited by the luminous grid targets was occurring.

The apparatus consisted of the ophthalmoeikonometer instrument, table, and hydraulic chair, and a target consisting of two miniature ophthalmoscope lamps mounted instead of the usual two lines in stereopsis tests.

The lamps were wired in series with 7.5 volts A.C. producing constant maximum brightness. A large piece of red Maddox-rod glass was placed before both eyes about 15 mm., so that the two small points of light appeared as two bright-red thin vertical lines without ends. The ends extended up and down about 45 degrees, but changed so with vertical eye movements that they could not serve in depth judgment. Nothing else in the room was visible in the 45-degree field straight ahead. Room illumination came from a diffuse source overhead. In Subjects 1 and 2, Table 1, the light was turned on bright for the light-adaptation test, and completely off for the dark-adaptation test. In other subjects, the overhead illumination was quite dim, so that the buff walls reflected only about 0.2 foot-candles on a light meter at eye level.

The set-up can be seen diagramatically in Figure 2. The two lamps were at "0" and "Fixation," and were 36.2 cm. apart, 192 cm. before the corneas. The usual variable axis-90° size lenses were used before each eye to introduce the disparity. The effect of separation of an afocal combination of minus and plus axis-90° cylinder to magnify the images seen by one eye is seen in Figure 2. With interpupillary diameters from 60 to 68 mm., the size lenses produced the effect of moving the luminous line at "0" back and forth at intervals of 9 to 11 mm. In the diagram, fixation is limited to the right line target, which is placed in the optical axis of the size-lens combination. The eyes were free to move from one to the other line target, in which case the disparity changes eyes but maintains equal angular space relationships. Slight movements of the head were prevented by the head holder but did not change the apparent distance of either line in any position of the size lens.

On the retina of the right eye in Figure 2 is seen the exactly corresponding point "0," and the disparate points from plus to minus 3. In the past, the diplopic images on each side of "0" were said to produce a "near" clue to depth, if temporal, and a "far" clue, if nasal, to the corresponding point.

In Figure 2, the retinal point "0" of O.S. corresponds exactly to point "0" of O.D., but the points from minus to plus 2 in O.D., although not corresponding, may fuse with "0" producing a stereoscopic cerebral image and perception of depth. These disparate

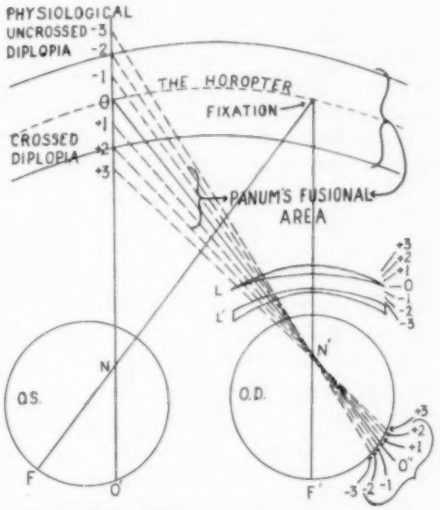

Fig. 2 (Miles). Diagram of experiment on stereopsis using luminous line targets at "0" and "Fixation." Stereopsis was found defective when the lines were placed at minus-3 or plus-3 positions.

images which fuse correspond to Panum's fusional areas, which exist before and behind the horopter, in which physiologic diplopia must be present but is imperceptible. The points minus and plus 3 outside this area may or may not appear as diplopic images, according to the attention or imagination of the observer.

The subject was seated before the apparatus, and the pupils aligned with the optical centers of the variable size lenses. The target was tested each time to insure that the subject could see both target lines equally well monocularly with each eye at all positions of the size lenses. The right size lens was set at 2 percent, and the left

was then adjusted until the subject reported the two lines appeared equidistant from the eyes.

The right eye was covered by the examiner's hand, while an adjustment of the right size lens was being made to any of the seven different settings used. Setting intervals, to produce the target movement described, were 0.50 percent. Any change of 0.50 percent in the size lens made an apparent movement of one target about 10 mm. by calculation. The setting made, the hand was removed to let the subject see binocularly. Sixteen judgments as to which line appeared nearer were required for each of the seven settings. The settings were presented in random order, with care that the subject got no clue whatever as to which direction the size lens was changed. The subject was required to guess right or left, if the target lines appeared equal. No suggestion of diplopia was made to the subject, and none volunteered that the lines ever appeared blurred or doubled.

All subjects had normal vision except U. L., who had 6/7.5 in the left eye. Four wore glasses. Two subjects, E. G. and B. T., had no stereopsis by the Maddox-rod test, although by usual tests it was normal. Results on 14 subjects are shown in Table 1. The plus- and minus-3 positions in the last eight subjects were made four times the 10-mm. interval, instead of three times. This was done in the hope of exaggerating the phenomenon and to decrease the chance that it is simply an experimental accident.

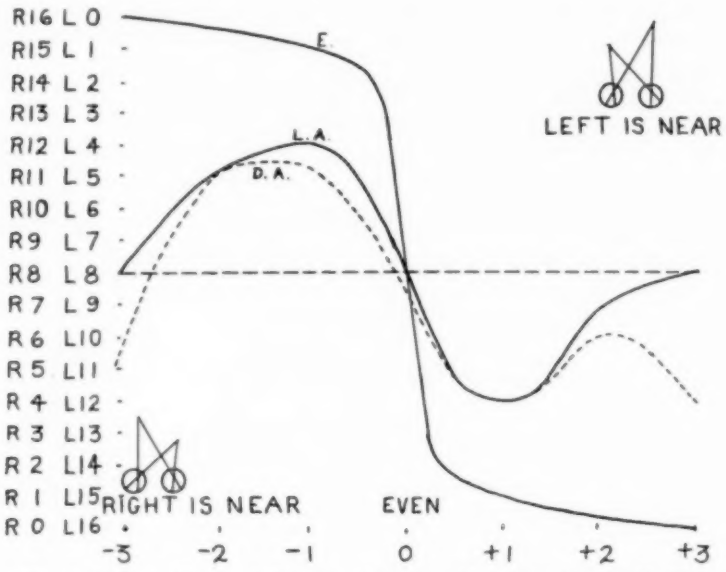

Fig. 3 (Miles). Sixteen judgments of each position presented graphically in Case 1 (M. B.). "E" represents the expected curves if stereopsis improves with distance differences of targets.

Figure 3 expresses graphically the results on Subject 1, compared to "E," the curve described previously by K. N. Ogle[3] in studies of sensitivity to changes in the space-eikonometer target position. According to "E," the nearer one target line is to the observer, the higher statistical chance there is of 100-percent correct judgments.

Figure 3 shows, in curves L.A. and D.A., that, when the two target lines were actually equidistant, the subject was declaring the right line nearer just as often as the left line nearer (R8-L8).

When the right or left line was brought 10 mm. nearer, the judgments made were 75-percent correct (R12-L4) (R4-L12) in each case, and, when brought 20 mm. nearer, the judgments were 62.5-percent correct. When the right or left line was brought still nearer, 30 mm., the judgments were again only 50-percent, which indicates no stereopsis.

In other words, M. B. had the best stereopsis when the disparity was least, and the worst when the disparity was greatest. From her horopter at 192 cm., Panum's fusional area was about 20-mm. wide. Of the 14 subjects, only four failed to show this phenomenon and, of these, two had no stereopsis with this type of test.

In Figure 3, the solid line L.A. refers to light adaptation, and the dashed line D.A., dark adaptation. Results are not conclusive, because the target background contrast is different in the two conditions, undoubtedly affecting stereopsis.

M. B. was tested again in the same equipment without the Maddox rods, without the size lenses, and using an apparatus with vertical line targets of the same separation at the same distance, introducing the same disparities mechanically. The vertical lines were aluminum wire about 3.75 mm. in diameter. A mask, 33 cm. before the eyes, obscured the ends of the wire in all positions. With the room illumination dim, and the background a painted black screen, no details were visible in the same 45-degree field as with the Maddox-rod tests. Results in the analogous positions were as follows:

−3	−2	−1	0	+1	+2	+3
0 16	1 15	2 14	4 12	9 7	6 10	10 6

The data are skewed, but no decrease of stereopsis occurred at the extremes.

This test was repeated with an aluminum background to decrease the contrast of the aluminum test objects, and the following resulted:

−3	−2	−1	0	+1	+2	+3
1 15	3 13	1 15	4 12	5 11	10 6	14 2

Discussion

The Maddox-rod line target for measuring stereopsis gives different results from those of other targets. One may review all known clues to depth perception, and find no difference between the two types of test. M. B. was tested on the aluminum rods monocularly and made largely incorrect judgments, confirming Howard's finding[2] that retinal image size difference is not a sufficient clue. Neither type of test involves different illumination of the two line targets. Parallax, overlay, perspective, and haze are ruled out. There cannot be much difference in convergence upon alternating fixation on the two lines of either type of target. Even if there is, convergence has been shown to be a poor clue to depth perception.[3]

There is definitely something about vertical luminous line targets which accentuates physiologic diplopia or prevents fusion of disparate images. The Maddox-rod line has no definite breadth when the light source is small, and it is an ideal straight line. One is reminded of the comparison of resolving power using two points with resolving power using two straight lines. The lines can be distinguished with 10 times more precision. It is the principle of the vernier, which is used in all precision measuring instruments.

Conclusive evidence that the thin straight-line concept produces the phenomenon described in this paper is found in use of the frontal plane apparatus[4] for measuring aniseikonia (fig. 4). This target is the complete opposite of the straight line, since it consists of irregular ink blots. When the target plane is placed at zero on the scale and observed from the position indicated by the head holder, it appears on a true frontal plane. When axis-90° size lens is placed before one eye, the plane appears to rotate on

its central vertical axis and will continue to rotate further with increasing magnification until about 25 percent has been attained. At this point, the frontal plane has rotated about 60 degrees. This high fusional amplitude of obviously disparate images is due to the irregular ink-blot type target which, although highly distorted, the cerebral centers will fuse. The Maddox-rod straight lines undergo diplopia at about 1.5 percent with loss of stereopsis.

The experimental findings described in this paper were found under conditions of artificial aniseikonia. The defects in fusion due to unequal sized images from the two eyes are well known. The artificial aniseikonia is not believed to be a factor in the present experiments because the Maddox-rod line target is of such indefinite thickness. The thickness varies constantly with the eye movements and, frequently, the line which appears slightly thicker is definitely more distant during tests.

However, to make certain, four subjects were tested with Maddox-rod targets in which the light bulbs themselves were moved mechanically. The same difficulties in depth judgment were found. Results on W. H. L., M. D., vision 6/6 without glasses were:

−3		−2		−1		0		+1		+2		+3	
11	5	12	4	9	7	14	2	14	2	13	3	16	0

With increasing nearness of the right target, judgment became worse and worse.

The possibility that stereopsis might again improve with still more increase in the binocular disparity was not studied in these experiments. However, there is a suggestion of such a trend in Subjects 1 and 6, in Table 1. Theoretically, it would not be expected unless parallax, or perspective, or size clues crept into the experiment.

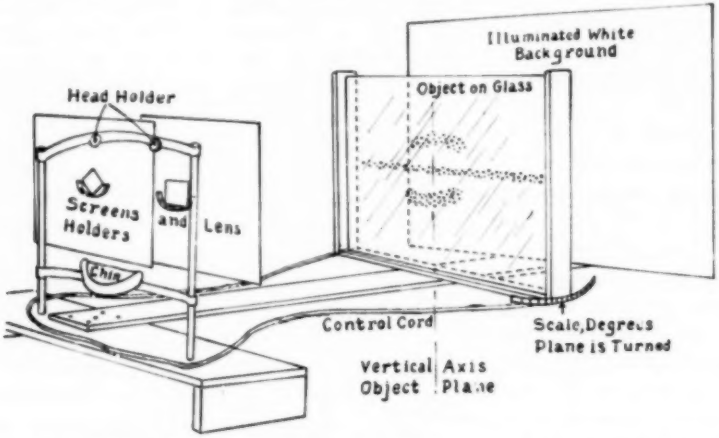

Fig. 4 (Miles). Frontal plane apparatus. The irregular ink-blot target will not accentuate physiologic diplopia like luminous vertical line tests do. The amplitude of this target is about 25-percent magnification, compared to about 1.5 percent for vertical line targets, before stereopsis deteriorates.

Summary and Conclusions

An experimental set-up is described in which more than a certain amount of difference in the distance of two vertical line targets from the eyes causes a deterioration of depth judgment. Tests were performed on 14 subjects with apparently normal eyes and normal stereopsis by the ordinary tests. Each subject was tested on a two-line target with the lines in seven different relative positions with 16 trials in random order of each position. Target distance was 192 cm., lateral

separation was 36.2 cm., and the variation of one line nearer or further was in three steps of about 10 mm. each, depending on the interpupillary distance.

This phenomenon is characteristic of thin vertical line targets and does not occur in the ordinary tests for stereopsis.

The evidence apparently modifies Hering's laws of stereopsis:[3] (1) That depth judgments are directly dependent on the magnitude of the retinal disparity, which is the deviation from strict retinal correspondence in normal binocular vision. (2) That depth judgment from noncorresponding points seen in physiologic diplopia is "far" for images falling nasally, and "near" for images falling temporally on the retina.

The extent of Panum's fusional areas at a fixation distance of 192 cm. is about 20 mm. from the horopter.

When testing patients on the space eikonometer, who do not immediately project the target properly or who do not appear sensitive to changes in the size lenses, one should consider that the stereopsis limit due to physiologic diplopia as described in this paper is being exceeded and that trial and error changes in the size lenses are advisable to pick up the target position in which the patient is sensitive.

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A SIMPLE, MORE ACCURATE MEANS OF CHARTING VISUAL FIELDS

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The first concept of perimetry was elaborated by Euclid,[1] who taught that a fluid streamed from the eye in the form of a cone with the apex in the pupil and the base on the object being looked at. The base comprised the visual field.

The field of vision was first illustrated by Ulmus of Padua in 1602. However, no further information regarding this subject appeared until the article of von Graefe in 1856.[2]

Many attempts to chart visual fields accurately have been made since the introduction of modern procedures about 50 years ago, as evidenced by the numerous articles published. The first perimetry was done with an illuminated object. In 1884, Abertotti used a "fluorescent" test object. In 1889, Bjerrum[3] stated that using one test object was like using only the 20/40 line for vision testing. He advocated multiple testing with various sized test objects. This was the method that prevailed until 1933 and to a large extent has prevailed since.

However, in 1933 Mayer,[4] seeking for a more adequate and reliable type of test, described the visual-field test done with a minimal light stimulus. In reviewing Mayer's work and the subsequent literature, it was found that his work had not been developed further, by himself or others.

In 1935, Mayer[5] described a means of

perimetry utilizing an apparatus for producing a minimal light stimulus of measured interval duration. His apparatus consisted of a condenser discharge into a neon bulb, thus producing a flash of very short duration and fixed intensity.

The apparatus was expensive and cumbersome. The flash of the neon was red and Dr. Mayer states that tubular fields were not present with this light stimulus. He also stated, "Varying slightly with the person tested," the speed of the flash, 0.033 second, is so rapid as to be lost at the 50- to 60-degree meridians. As more peripheral meridians are approached, the flash is lost at lesser speeds.

Thus, it was concluded that Dr. Mayer was endeavoring to find a much more quantitative visual-field test. He stated, however, that the advantages of this type of stimulus are that it is critical and it eliminates a moving target.

A moving target, in itself, has definite inherent disadvantages: (1) There is much poorer control of fixation however good the fixation device; (2) there are variable effects of previous exposures on the sensitivity of the retina; and (3) there is a time error which cannot be standardized.

The criticisms raised by Mayer and his attempt to remedy the disadvantages are readily apparent when one considers the apparatus he developed and its inherent difficulties.

Development of new apparatus

Our own objective was to get a simple, inexpensive, reliable machine which would render visual field taking easier and more accurate and would dispense with multiple test objects. In an effort to achieve a more reliable test object (light) for perimetry, an inexpensive apparatus was developed by the Chart-lite Instrument Company of Los Angeles. This instrument produces a pulsing light in the form of a flash of measurable duration, which can be accurately controlled and easily varied in intensity and frequency.

The usual technique may be employed in determining visual fields with slight variations. Our technique was to move the light slowly from the periphery to the fixation point, moving more slowly or stopping at the critical point in the field where the light was observed. A movement of one-half inch at this point, in most cases, eliminated the light or made it appear. There was no hesitation or indecision on the part of the patient, because the flash is clear cut and definite. This same advantage holds for central fields. These were taken on the Gruss tangent screen. The blindspots, when outlined with this apparatus, are better than textbook illustrations.

Another refinement, which we were able to introduce, was in the cases of poor central fixation. In these cases the central target for fixation could be made any size. We have used a white disc 12 inches in diameter with crossed lines. The patient fixes easily and yet the scotoma is beautifully outlined because the pulsing light passes from black on to the fixation target without disturbing the patient's fixation.

The fields were taken on the optical perimeter and on the tangent screen, using the same arm to hold the light, and the perimeter was painted black. The optical perimeter is the one mentioned previously, as constructed under the supervision of Ferree and Rand.[6] Two arcs of the same radius of curvature were constructed at right angles to each other—one, a 180-degree arc, the perimeter arm; the other, a 90-degree arc, the lamp arm, at the end of which is placed the source of light. The two arms are fastened together at the center of rotation.

A housing shields the lamp from the patient. This housing is made of black japanned iron and is painted a mat black on the inside in order that all of the light that passes to the perimeter arm will, as nearly as possible, radiate directly from the lamp filament.

Its dimensions are 4¼ by 4¼ by 5 inches. Filtering the light to daylight quality is accomplished by using as a source of light a well-seasoned, 75-watt type C_2 (blue bulb) Mazda lamp operated by ammeter and rheostat control. The surface of the bulb is acid-etched to diffuse the light.

A chin rest on a tridirectional stand is placed at a distance of 33 cm. from the central fixation point, which is the center of these intersecting arcs. The horizontal arc is marked in degrees up to 90 in two directions from the center. Fixation is controlled by sighting through the hole of the bisecting arcs. A movable ratchet allows for the eye of the observer to be regulated at the 33 cm. distance from the fixation point. Seven and a half foot-candles is the amount of light generally recommended and is controlled by the ammeter and rheostat mentioned previously.

The light test object consists of a six-volt straight filament bulb that produces a very even and efficient source of illumination. This light is mounted on an 18-inch rod that serves as a light wand. A flexible wire permits complete freedom of motion of this light source (wand) in determining the visual fields. The wand is coated with a non-reflecting black lacquer to eliminate possible reflections resulting in false readings; our perimeter being black, the same wand is used for tangent-screen work. For perimeters of a gray color, a wand of the same color may be substituted.

In order to make this procedure utilizing the light technique comparable to that employing multiple test objects, it became necessary to be able to vary the intensity of the test light. This has been incorporated into the instrument so that the light intensity may be varied from zero or no light to an intensely bright light. The intensity range is gradual from zero to bright so that extremely small increments may thus be obtained.

A means has also been included to vary the speed or frequency of pulsation or flashing of the light. Four speeds have been found to be optimal in the results they produce; that is, flashes occurring at intervals of one second, one-half second, one-third second, and one-quarter second. Provision has also been made for manually controlling the rate and duration of the pulse so that the intensity, frequency, and duration of the flash may be varied to any desired pattern, each one completely variable and independent of each other. The instrument is very compact, is about six-inches square, and is readily portable (fig. 1).

Comparative tests were made with this instrument on a number of cases for charting

Fig. 1. (Zugsmith and Rehman). A new instrument for charting visual fields.

normal visual fields and these were plotted against the various sized test objects normally used. The technique of using a pulsing light was found to be quite simple. Since the flash is of definite intensity and duration and the target is stationary in nature, the patient error is minimized or eliminated.

The calibration was difficult since we were unable to obtain a light meter which would record the intensity of the flash in lumens or foot-candles because the duration was so

short as not to be able to overcome the lag or latent period of the various meters used. We found an arbitrary point of intensity on our machine which was comparable to the 1-mm. white test object.

Reeves[7] has estimated the least amount of radiant energy which would excite the retina sufficiently to give rise to a perception of light. This light is well above this minimal stimulus, but not high enough to produce an after-image. It has been shown that the rods are the rapid organs and the cones are the slow factor in the reaction to light[8] and a flash as rapid as the one used will not exhaust the retina.

Summary

A mechanism is presented, which is inexpensive and yet more reliable and more accurate than the test objects. The patient finds this test easier and more definite than one with nonluminous test objects and the physician has, at the turn of a control, various sized objects for both perimeter and tangent-screen work.

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THE LEARNING PROCESS IN ORTHOPTICS*

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The visual act has two distinct parts. One part consists of the mechanism for receiving an image with each eye, the other part consists of the means by which the two images are coördinated and interpreted in the brain. From another point of view, binocular vision may also be considered to have two parts; an innate structural, reflex part, which matures in the normal growth process, and a more complicated part which requires use, experience, and interpretation to develop fully.

Orthoptics is concerned with developing normal binocular vision and is almost entirely limited in its applications to this second field of development; that which takes place by use and interpretation and the acquisition of binocular skill. Orthoptics cannot alter growth, it cannot change, as can the surgeon, anatomic and pathologic conditions which prevent the normal maturing of each eye. It can only work with the kind of eyes ophthalmologists have been able to obtain for the patient by occlusion, refraction, surgery, or other treatment. It is then the function of orthoptics to help the patient acquire the best binocular skill of which these eyes are capable.

If there is some insuperable obstacle to binocular vision, such as a permanent amblyopia or an uncorrectable deviation, it is beyond the possibilities of orthoptic training to obtain normal binocular vision in such cases. Fortunately, for ophthalmic progress, many conditions once thought insuperable are now correctable, and binocular vision is becoming correspondingly more frequently attainable.

BINOCULAR VISION PERFECTED BY LEARNING

The process by which binocular vision is perfected is the learning process. This is true whether it is acquired in the normal development of the child or by deliberate training in orthoptics. Learning is purposeful adaptation to environment, to the constant stimuli which the organism is receiving. Since it is innate in the organism to respond to stimuli, learning consists of making responses which are an effort to make useful adaptations.

If such adaptations are successful, they are accepted by the individual as useful learning and are repeated each time the stimulus is received. If they are unsuccessful, they tend to be discarded and something else is tried next time. Thus learning becomes a kind of trial-and-error.

The learning of visual skill is no exception. The growing infant experiments with the various aspects of the visual act. For the safety and welfare of the individual, it is highly important that he acquires a clear single image. Hence the mechanism for achieving it is mostly innate and develops at the reflex level.

Some portions of the mechanism are not mature at birth, and it takes nearly eight years before full growth and visual acuity are achieved but, as the correct age is reached, each factor in the growth pattern matures, ready for use.

If, during the growth and learning period, anything interferes with the opportunity to get normal use and experience, the visual act will not come to normal completion. It is also true that if, after normal skill is acquired, something interferes with constant practice of the skill, it will not be maintained and may decrease. It will certainly not improve.

It is, therefore, of the utmost importance that the growing child shall first get enough practice and use of each eye to permit the innate growth processes and reflexes to come to maturity; secondly, get the practice in

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binocular skills necessary to learning to use both eyes correctly; and finally, have opportunity for abundant interpretive experience.

Levels of learning

Learning is essentially a stimulus-response mechanism. It differs from the simple reflex by the highly complicating factor of the emotions and the intellect or cortex of the brain. Strictly speaking, learning may take place at four different levels: (1) The somatic or body-growth, (2) the neuromuscular or reflex, (3) the intellectual or cortical, and (4) the emotional.

Because of the innate and hence nonmodifiable character of the somatic and neuromuscular responses, they are rarely included in the classification of learned responses. They require opportunity for experience and, as soon as experienced, are learned—that is, accepted by the organism for repetition.

It is responses that involve the mind and emotions that are highly modifiable and hence considered as learned responses. There is opportunity for choice in the response, and the chosen response is the learned response. The borderline is not sharply drawn since many reflexes are neuromuscular in character, and much neuromuscular learning is initiated at the cortical level.

The primary method by which the infant learns binocular control is through the experience of diplopia. The desire for a clear single image is innate, the dislike of diplopia is equally instinctive. The infant responds in various ways to his binocular stimuli, discards the responses that give him diplopia, and accepts the satisfactory responses that give him single vision. In this essentially simple manner he learns binocular skill.

So far as is known at present, there are only four ways in which a single image can be achieved: (1) By normal fusion of the images from the two eyes, (2) by using only one eye at a time (the other eye may be amblyopic, or it may be suppressed), (3) by developing anomalous correspondence, and (4) by the Swan syndrome (turning one eye so that the stimulus to vision falls on the blindspot).

The two latter methods are comparatively rare. The vast majority of abnormal adaptations to binocular vision are by suppression. Any of these adaptations mean that the infant has successfully achieved a single image; he has learned how to solve the problem of binocular vision. If there is no obstacle to the development of fusion, that will be his response but, in the presence of certain obstacles, fusion will be either difficult or impossible and he learns some other way out.

Obstacles to fusion

The commonest obstacles to fusion are amblyopia of one eye (visual acuity less than 20/70), strabismus, hypermetropia, and anisometropia. Less common causes include aniseikonia, congenital defects, whether anatomical or neural, phorias, and developments of later life such as convergence insufficiencies which lead to abandonment of binocular skills previously acquired.

Strabismus is an obstacle since the deviation of the eyes makes fusion impossible. Unless the eyes can be moved so that the images fall on the foveas, fusion is impossible. Hypermetropia is an obstacle because, in order to see clearly, the patient has to overaccommodate, which leads to overconvergence and hence to loss of fusion.

Anisometropia is an obstacle because the two eyes are so different that fusion is difficult and hence frequently abandoned by the patient. Phorias also require much adjustment which the patient may give up for the easier method of single vision by suppression. The growing infant and child thus learns to adapt to his binocular stimuli in such a way that his response is a single image.

How learning takes place

Five steps are necessary for each tentative response, and only the satisfactory completion of each step will lead to learning.

1. Attention

The stimulus must receive attention. The organism is constantly bombarded by stimuli both from within and without. Most of them are ignored; no learning takes place in connection with them. The organism must select the stimulus to which it will respond before a response will be made.

2. Recognition or awareness

This is a cortical and emotional factor, not necessary at the reflex level, but of the utmost importance in establishing the conditions necessary for learning. It is the place at which the organism recognizes that the stimulus to which it is attending has possibilities for response. It is the point at which a decision is made to continue with the experience and not discard it as of no interest or value.

If attention is not followed by recognition, the learning process stops at once and the individual frees himself for attention to further stimuli.

3. Response

Response inevitably follows recognition. As soon as the organism recognizes a situation it becomes necessary to make a response. The response may be positive or it may be inhibitory. Inhibition is a very important type of response. Response is the keystone in the arch of learning. As soon as a response is made, learning is on the way to achievement.

4. Satisfaction

Again emotions enter the learning process. The response inevitably results in some feeling about the situation; satisfaction or dissatisfaction. This is the point at which learning succeeds or fails. If the response is satisfying, it is accepted as learned response and is ready for repetition. If it is dissatisfying, the individual avoids repeating that response and learning is blocked.

5. Repetition

It is at this point that learning is established as part of the individual. Adequate repetition is necessary to make the same response assured. It is by means of repetition that habits are established. Habits are the result of responses repeated so often that the steps involving the emotions or intellect are by-passed in the stimulus-response sequence. They become similar to reflexes. Since binocular vision should be the normal habit of the individual, adequate repetition is necessary, whether learned normally in infancy or artificially by orthoptic training.

Orthoptic training functions by taking the patient through the five steps of the learning process in binocular vision as rapidly and efficiently as possible. It does not function in any other way. It does not do anything to the patient or his eyes; it merely offers special opportunities for him to take the steps of learning under guidance. This kind of guidance is teaching. The technician teaches; the patient learns.

Teaching consists of offering selected stimuli to the patients so that the correct response will be easy and give him the satisfaction necessary for repetition, and sufficient practice in these responses so that they become habitual.

Orthoptics is not a treatment done to the patient; it is an opportunity offered to the patient. It is subject to the limitations inherent in all opportunities; they may be accepted or rejected by the patient. They may be rejected at step one; he may fail to attend to what is going on. He may fail at step two; he may reject the situation as one he does not care to recognize or take an interest in. He may fail to get satisfaction out of the response he makes, or he may not repeat it ofen enough to establish habits. The only thing he cannot fail to do is make a response of some sort while he is in the office.

This is an important fact because, if the response he makes is not the desired one, he is actually learning something different from the intended skill. Practice in faulty responses leads to bad habits. This is the reason that poorly conducted orthoptic training is worse than no orthoptics for the patient. He

may simply get a set of experiences in doing the wrong thing.

Evaluation of orthoptics

Orthoptics should be evaluated for the skill with which the right opportunities are offered, the wrong ones eliminated, and by the resulting satisfaction to the patient when he makes the right responses and dissatisfaction when he makes the wrong ones. This standard reduces orthoptics to its simple essential elements.

There are many factors involved in creating the right opportunities. They form the teaching triangle of the patient and his specific problem, the facilities available for his orthoptic training, and the skill of the technician in applying the facilities to the patient.

Since learning is response to stimulus, if the patient is unable to respond to a given stimulus, no learning takes place. For this reason it is of no value to expose a patient to difficult and impossible situations.

An example of this is the patient with an amblyopic eye who is asked to fuse. If he cannot see the object presented for fixation, he cannot get a second image to fuse with the better image, and he learns nothing about fusion.

If he is partially amblyopic, and can see when the image in front of his amblyopic eye is very brightly illuminated, he may then be able to fuse, and profit by this specialized experience, but when the illumination is decreased below the threshold of his perception the learning that has taken place no longer has any stimulus to start the fusion response, and there is no opportunity to continue the practice of fusion.

Another example is the patient who cannot fix steadily with both eyes. It may be because he has a habit of alternation, and changes fixation from one eye to the other at random, suppressing the nonfixing eye. Patients with a phoria often have intermittent suppression that prevents stable binocular fixation. As long as they do not fix steadily with both eyes they cannot start to learn the advanced steps of binocular vision, and it is useless to expect them to practice vergence control or stereopsis.

Suppression is the commonest cause for failure to profit by orthoptic training. Unless the patient uses both eyes he cannot fuse or develop the other skills of binocular vision.

Orthoptic learning begins with binocular fixation, and proceeds through the subsequent steps of vergence control, accommodation-convergence control, and training of the perception of color, stereopsis, and other interpretive skills.

The learning process requires not only that the anatomic mechanism for transmitting images shall function adequately, but that the individual shall be emotionally receptive to the stimuli so that the interpretive portion of the visual act shall be completed with satisfaction. If the patient does not give attention to the stimuli, or is not aware of what he perceives, or is not satisfied with his sensations, learning stops.

Anomalous correspondence functions so as to give the patient satisfaction with his adjustment at a reflex level and is usually associated with suppression. In some cases the anomalous correspondence reflex is so firmly established that it is beyond the power of the individual to inhibit it and distressing postoperative anomalous diplopia persists, despite all efforts to develop normal fusion skills. Variations in results in attempting to correct anomalous correspondence may often be traced directly to variations in sound application of the learning factors, or in the innate teachability (adaptability) of the patient.

Establishing emotional attitudes

Learning stops when the patient decides, whether justifiably or not, that the situation is too difficult. A large part of orthoptic teaching consists, not of arranging suitable optical set-ups for binocular experience but of establishing emotional attitudes on the part of the patient so that he will take the necessary steps in learning. He cannot be

forced to learn but he can be eager to learn.

A certain amount of discipline may be important in controlling attitudes, but the difference between establishing opportunities, and securing use of the opportunities (which is learning) must be clearly understood. Any portion of the visual act which is subject to either inhibition or choice-of-responses, is subject to learning.

Inhibition is itself a choice of response, but it is classed separately because of its importance in controlling reflexes. Reflexes, which, being innate, cannot be altered, can be inhibited under certain conditions. This is why orthoptics reaches down to the very fundamentals of binocular vision in developing normal habits; the abnormal adjustments previously made by the individual must be inhibited before normal responses can be established.

Inhibition is a very difficult response to make to a reflex stimulus. Because of their innate mechanism, reflexes are very strong and prompt in their control. Moreover, inhibition cannot be forced upon an individual. It is an emotional type of response that has to be exerted from within. The desire to inhibit must precede the act of inhibition.

This inhibitory control is slow to develop in the individual; it is definitely an attribute of maturity. This is a primary reason why young children cannot change their pattern of binocular control once it is established. They are not sufficiently mature in their inhibitions to inhibit the reflex patterns they have already learned, preparatory to learning new ones.

If the extent to which normal binocular vision is a learned process is clearly understood, the process of orthoptic correlation of faulty binocular vision may be more easily analyzed.

Anatomic and physiologic factors

Normal binocular vision depends upon the slow maturing of anatomic and physiologic components involved. The first imperfect images received by the infant require only the simplest interpretation of direction and size. He does not need to make complicated interpretation of form and color since he has not sufficiently accurate data (clear images) to work with.

There are only three kinds of errors which can be made at the reflex level (1) Errors in direction, or fixing the desired object; (2) errors in accommodation, or getting a clear image; and (3) errors in fusion, or getting a single image.

Patients may fail in one of these factors or in a combination of two or more. All the time that the growing infant and child is getting practice in establishing a clear, single image of the object fixated, he is also getting a vast amount of interpretive experience in learning about what images mean. He is also building up a body of satisfactions and dissatisfactions with his results.

If his growth processes are normal, by the time he is eight years old he has developed normal binocular vision. If, during this growth period, something interferes with his ability to fixate, to accommodate, or to fuse his two images, he will develop an abnormal adjustment to binocular vision.

Due to his anatomic and physiologic immaturity during this period, such adjustment is reflex in character, with all the reflex attributes of becoming the innate responses, of by-passing the cortical-willed impulses, and of not being subject to further choice and change.

The fundamental reason that the patient makes such faulty adjustments is because of the comfort or satisfaction that results from them. Thus the emotion of satisfaction is the tool with which the child works to establish his visual habits. These emotions of satisfaction are even more innate than normal visual reflexes. The comfort of clear single vision will be achieved by abnormal reflexes when necessary.

The visual mechanism is such that it is possible for the patient to get comfort and satisfaction in several different ways. He is not limited to the normal way, by fusion. If

the condition which prevented the patient from developing normal fusion persists, he is as well adjusted as it is possible for him to be when he uses one of the alternative solutions of binocular vision, suppression, anomalous correspondence, or the Swan syndrome.

If, however, the original cause is corrected, as by refraction or surgery, then his original adaptation is no longer necessary. If the correction takes place while he is still young enough to be developing and experimenting with binocular vision, he has a good chance of accepting normal fusion but, if he has fully established his reflex adjustment in an abnormal manner, he will continue to use these reflexes and fail to take advantage of improved binocular opportunity. The mere presence of improved opportunity is no guarantee that the patient will use it.

The factors which control the learning process are the ones which will determine the use the patient will make of his opportunity, and the emotions are a predominant factor in the learning process.

Progress in orthoptics

It is the function of orthoptics to guide the patient through the steps of learning binocular vision. To find out whether it will correct a given problem—that is, develop normal binocular vision for a specific patient—it is necessary to know how fully such a patient meets the requirements of the learning process.

This is the science of prognosis in orthoptics, still one of the most uncertain fields in the orthoptic procedure. It need be uncertain only to the extent that the learning factors cannot be determined. The more such factors can be evaluated as part of the original diagnosis the more certain prognosis becomes. Many of the factors are discoverable only by a trial period. This is why orthoptics is so largely empirical. It is gradually becoming less so as the learning process is more completely understood and fully applied.

There are four obstacles to satisfactory binocular learning. One has already been discussed; the patient who cannot fuse, who has an insuperable obstacle to normal binocular vision. There is still some uncertainty about what constitutes an insuperable obstacle, and more orthoptic research will be needed before such patients can be diagnosed conclusively. This applies especially to the "neuro" portion of neuromuscular disturbances, to patients in whom the etiology of strabismus is "unknown."

The second obstacle is the patient who does not accept the necessary steps in the learning process, who fails to give attention, to recognize the orthoptic situation, and to get satisfaction out of binocular effort. The most usual cause of failure in this group is immaturity. They may be immature due to calendar age, or for other reasons. Many adults do not take a mature attitude toward their visual problems.

The third group of patients fail because the fusion problem, while not insuperable, is too difficult for habitual use. This includes patients with insufficient surgical correction, and some of the phoria cases. It also includes some cases of anomalous correspondence. These patients are often able to learn orthoptic skill, but are unable to apply it continuously for casual seeing.

The final obstacle to orthoptic success consists of inability to learn to recognize the difference between single vision by fusion and by the previously developed reflex adjustment. Many cases of exotropia fall into this classification. They are characterized by inability to perceive diplopia when fusion fails.

All orthoptic failures fall into one of these four groups. Orthoptic progress is largely concerned with group two; the better the teaching skill the fewer failures in learning. The other groups are inevitably mostly the responsibility of the ophthalmologist who must improve his preparation of the patient for binocular vision to the limits of ophthalmic knowledge by removing all possible obstacles and making fusion easier.

Art of orthoptic teaching

The foundation of learning is the satisfaction resulting from a specific response to stimulus. This is why the orthoptic situation must center around the individual. No matter how scientifically sound the optical arrangements for binocular vision may be, if they do not result in satisfaction for the patient they will not result in learning. They will not meet his needs if they are beyond his capacity at either the physical or emotional level. He must be able to respond physically and to get satisfaction emotionally out of the response.

The primary response is simultaneous perception—the use of both eyes; the primary satisfaction is a clear single image.

When, by using both eyes, the patient gets a clear single image he has taken the first step toward establishing fusion as his response to binocular vision. Because of the fact that he is a patient, and not a normal individual, if he uses both eyes he will probably get either diplopia or a blurred image.

The art of orthoptic teaching is to give the patient sufficient satisfaction with his preliminary binocular experiences so that he will continue making new responses and not give up and fall back on his old reflexes.

All satisfactions may be grouped into two classes, physical and social. Orthoptics is obliged to make much use of social satisfactions to stimulate learning, since much orthoptic learning is far from physically pleasing to the individual. Hence it is easy to see that, if the patient is too young, or otherwise not amenable to social satisfactions, orthoptic learning will not be satisfactory.

There are many levels of satisfaction. A child may "hate" his orthoptic lesson, but if he hates the attitudes of his parents or technician when he has a poor lesson even more, the outcome will be satisfaction with a lesson well done. The manipulation of the lesson situation in such a way that the satisfactions for work well done outbalance the dissatisfactions of tedium, physical unpleasantness (such as diplopia), and the discipline of inhibition is the basis of orthoptic teaching skill. The ability of the teacher to impart enthusiasm to the patient is part of good teaching.

The second corner of the teaching triangle is the selection of equipment and the creation of situations in which the correct response will be made by the patient. These are the facilities of orthoptic environment, which make binocular vision possible as it has not been possible before in the history of the patient.

It was the development of orthoptic equipment which was the first great forward step in the history of orthoptics. Failure to realize that exposure to such opportunity by means of this equipment was not the final step but only the preliminary step to binocular vision retarded orthoptic development by many years.

Nevertheless, the importance of adequate equipment is very great. At the present stage of orthoptic technique, it is still essential. Good equipment makes efficient teaching possible. Poor equipment need not prevent all efforts at orthoptic education, but it makes it unnecessarily tedious and difficult.

The technician herself is the corner that closes the teaching triangle. Her skill in adapting situations and creating attitudes is what determines how successfully the learning process will take place. The selection and application of equipment and facilities to each patient, day by day, and minute by minute, at each step in his binocular reëducation is the responsibility of the technician. It is the art of teaching. Orthoptic speed and success depend upon her ability in this field.

Summary

Binocular vision is a learned process. The mechanism for achieving it is preformed and the correct reflexes are innate. In the normal child, the development of the correct adjustments for normal fusion takes place during the first six years of growth. If some abnormality interferes with normal binocular vision 1 of 4 abnormal adjustments will be

learned instead; suppression, anomalous correspondence, the blindspot syndrome, or abandonment of single vision. This last adjustment is, of course, diplopia, rarely adopted by the child, but more frequently by the adult. If such abnormal learning takes place when the individual is sufficiently immature, it becomes the reflex adjustment of that individual.

Reflexes take precedence over other types of response, and cannot be altered, but can be inhibited. If the original need for an abnormal adjustment is corrected, the patient can learn normal responses.

There are four causes for orthoptic failure: an insuperable ophthalmological problem, failure to accept the learning process, lack of fusion comfort, and inability to recognize fusion errors.

Opportunity to learn does not necessarily result in learning. All the factors for learning must be present in order that learning will take place; attention, recognition, response, satisfaction, and repetition. Emotions, especially satisfaction, play a large part in the learning process.

Unless an orthoptic situation is created in which all the factors in learning are present in the right manner at the right time, binocular vision will not develop efficiently.

490 Post Street (2).

Discussion

Peter C. Kronfeld
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I am well aware of the fact that I am very poorly qualified to discuss Miss Lancaster's paper. One obvious reason is that I have had very little practical experience in the administration of fusion training. Another reason is that during the last few years I was engaged in a type of work in which I had to concentrate on the detection of cases of partial or complete failure of fusion training.

In 1944, I was appointed a member of a committee of the National Research Council that was to concern itself with medical problems in civilian aviation. The Civil Aeronautics Administration requested this committee specifically to include in the examinations of the applicants for pilots' licenses some test that would permit the distinction between genuinely normal binocular systems and systems that might be called patched-up ones, patched up either by surgery or surgery plus fusion training. The Civil Aeronautics Administration did not intend to bar such patched-up systems but wanted to have such systems detected and properly recorded, so as to determine whether the flying ability of the bearer of such a system differs demonstrably from that of genuinely normal systems.

At first I did not think that there was such a test that could reliably be administered by physicians without special training in ophthalmic examinations but, after extensive trials and errors, I became convinced that a modified Howard-Dolman test served the purpose of screening out inferior binocular systems very well.

In the course of this work, a great many cases of failures of fusion training have come to my attention. Nevertheless, I have tried to maintain an unbiased attitude for which I have been repaid by discovering a few cases which, as a result of fusion training, attained the highest degree of binocular coöperation, namely, an acuity of binocular depth perception of the same magnitude as that of a genuinely normal system.

Miss Lancaster's paper deals specifically with the psychology of the process of learning in orthoptics. She describes five essential

steps in the learning process—attention, awareness, response, satisfaction, and repetition. These steps seem significant and real, not only to the professional educator but also to the ophthalmologist and physiologist.

Following the terms introduced by the school of Pavlov, we often use the term "reward" instead of satisfaction. A number of years ago, I was engaged in trying to acquire a specific binocular skill, that of pseudoscopy. As you all know, pseudoscopy consists of the reversal of stereopsis by offering to a normal binocular system the "wrong" image of a three-dimensional object. A pyramid or a cube, photographed with a stereo-camera may serve as such an object. The two images are then offered to the "wrong" eye, fusion being obtained either by crossing one's visual lines in front of the images or by special pseudoscopic devices.

Such reversed images of simple three-dimensional objects very promptly and instantaneously produce the reversal of the depth effect, that is concavity, where there actually is convexity and vice versa.

If the viewed object, however, is well known to the observer, his empirical knowledge hinders the reversal of stereopsis. The stronger these empirical factors are, the more difficult it becomes to perceive reversed stereopsis. By systematic training, however, one can learn to free oneself of these empirical factors and to perceive the reversed stereopsis readily and instantaneously, despite the presence of strong empirical factors.

I subjected myself to such fusion training and, recalling my subjective sensations during that training, can very readily recognize the five steps in the training discussed by Miss Lancaster.

There are two statements in Miss Lancaster's paper that I would like to stress specifically. She advises us to distinguish carefully between fusion failure due to lack of opportunity, and fusion failure due to a specific fusion inability. I believe that this is a very important distinction.

The busy ophthalmologist in an office full of urgent major pathologic problems, is especially apt to forget that, in the case of a system with one "weaker" and one "stronger" eye, it is important to choose for the fusion test a pattern, the important parts of which can be readily perceived by the weak eye.

Most ordinary cards or slides designed for fusion tests are too difficult for an optically or perceptually inferior eye, and it is very often because of that inferiority that no fusion occurs, the examinee simply not seeing the important elements of one half of the test card. If the essential parts of the pattern offered to the weaker eye are of sufficient magnitude and impressiveness, in many such cases a true act of fusion can be demonstrated.

In her summary, Miss Lancaster states "that binocular vision is a learned process; the mechanism for achieving it is preformed and the correcting reflexes are innate."

This may seem like a radical departure from Hering's classical view of the purely innate character of binocular depth perception due to horizontal disparity. Having been an ardent admirer and follower of Hering all my life, I believe that if he could have witnessed the recent developments in our knowledge of binocular sensory coöperation, he would have worded his concept of binocular coöperation very similar to the way in which Miss Lancaster has done.

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NOTES, CASES, INSTRUMENTS

ECTOPIC LACRIMAL PUNCTA

A CONGENITAL ANOMALY ASSOCIATED WITH ABSENCE OF THE LACRIMAL PAPILLAE AND CAUSING CHRONIC TEARING

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Congenital abnormalities of the lacrimal puncta and canaliculi are usually considered in any discussion of chronic tearing, but practically no mention is to be found concerning the importance of small degrees of malposition of the puncta other than in cases of ectropion. It is the purpose of this report to emphasize careful study of the location of lacrimal points and to establish ectopic puncta as a rare but occasionally seen congenital anomaly responsible for epiphora.

Fig. 1 (Keeney). Ectopic, inferior lacrimal punctum. The slightly ovalized and gapping point is located on the lacrimal portion of the lid border and is directed superiorily so as not to be in contact with the lacrimal lake.

Development of the canaliculi and papilla in solid epithelial cells occurs at the 35- to 36-mm. stage.[7] The superior canalicular segment buds directly from the sac anlage and traces its course through the upper lid.

Less simple, however, is the development of the inferior canaliculus. This buds from the advancing upper canalicular segment rather than from the sac anlage and, in the course of its lateral growth, cuts off a medial portion of lid tissue to create the caruncle.[3, 6, 7]

Thus, there are more opportunities for developmental faults to occur in the lower than in the upper portions of these passages, and clinically more anomalies are found in the lower portions. Canalization of these rods of cells begins in the 35-mm. embryo and is essentially complete at the 6-cm. stage, except for the puncta which open just before the lids separate in the seventh month.

Ida Mann[5] indicates the two basic mechanisms whereby faults may arise: (1) The buried epithelial buds which trace out the canaliculi and their opening may pursue abnormal courses, or (2) the structures, originally blocked out in solid epithelium, may not canalize. Miss Mann and others* have specified that by these mechanisms there may result (a) total absence of the puncta, (b) dimplelike, imperforate puncta, (c) atresia of the puncta, (d) occlusion of the puncta with epithelial plugs, (e) elongated or slitlike puncta, (f) shallow gutter openings in the canaliculi, or (g) accessory puncta.

In addition to these anomalies should be listed ectopic puncta. A review of French, German, and English literature since 1836 reveals only four such cases reported in this country[2] and three cases reported from France.[1] Another French case reported by Lempert[4] in which he described fissurelike openings 2 and 3 mm. long located medial

* Blanchet, 1846; Cabannes, 1896; Nielsen, 1896; Fox, 1900; Lebeque, 1910; Lempert, 1920; Schaffer, 1921; Towne, 1943; Brooks, 1944; Hendricks, 1944.

to the usual site is only a slight variation of this anomaly incorporating also the characteristics of slitlike puncta. One additional case is reported herewith.

Case report

History. The patient, a 23-year-old white man, complained of moderate epiphora as long as he could remember. His parents state that he had "watery" eyes even in infancy. Temperature changes, wind, or excitement caused tearing onto the cheeks. There is no family history of this disorder. Gestation and birth were apparently normal. There have been no infections in or near the eyes and no previous illnesses other than the usual childhood diseases. He has had repeated lacrimal probings by other physicians in 1945 and again in 1947, but never with any improvement. He states that Bowman probes up to size 9 have often been passed.

Complete physical, ophthalmic, and rhinologic examinations were negative except for the lacrimal findings and a perforated left ear drum. Examination under magnification revealed no evidence of lacrimal papillae on the lower lids. Transition of the lid border between lacrimal and ciliary portions followed the usual configuration and there was no ectropion.

The superior canaliculi opened by normal appearing, round puncta directed posteriorily at the junction of the lacrimal and ciliary portions of the lid border. Each inferior canaliculus opened through the lid border at the junction of the middle and outer thirds of the lacrimal portion and formed an acute angle of about 15 degrees with this free border.

The puncta thus formed had no papillae, opened directly upward, and had no contact with the lacrimal lake. The puncta gapped slightly and were ovalized so as to measure about 0.3 by 0.8 mm. in size.

Irrigating solution was delivered with ease from any punctum into the nose. X-ray films taken after lipiodol installations through the lower puncta showed the remainder of the passages to be entirely normal.

Comment. The upper puncta were able to function by the normal processes of capillarity, but because the lower puncta were not directed against the bulbar conjunctiva, they were ineffective to drain the tears. Both lacrimal glands appeared somewhat smaller than usual.

The most logical explanation for this pathologic condition seems to be an aberration in the developmental course of the canalicular buds at the 34- to 35-mm. stage, whereby they open onto the lacrimal portion of the lid border, instead of continuing laterally to the usual site on the ciliary portion. The role of constricting amniotic bands, mentioned by van Duyse and van der Hoeve,[7] which might prevent lateral growth of the buds by direct pressure, remains speculative.

Summary

A case of chronic tearing caused by congenitally ectopic puncta is presented. The inferior puncta are located on the lacrimal rather than the ciliary portion of the free border and are directed superiorly rather than posteriorly. Capillarity is hence impossible. The developmental mechanism is reviewed.

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BILATERAL HOMONYMOUS HEMIANOPSIA CAUSED BY VASCULAR OCCLUSIVE DISEASE

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In January 1943, in the *Archives of Ophthalmology* (**29**:92-97), was reported a case of "Bilateral thrombosis of posterior calcarine arteries with sparing of macular vision" by P. Robb McDonald of Philadelphia, in which it is mentioned that such cases are rare. The author was able to uncover only one other case in this country and that was by Dunn, in 1895. Accordingly herewith is reported a case that I believe to be similar, although the lesions, which seem to be the same in nature, probably are slightly different in location.

In Rucker's monograph prepared for the American Academy of Ophthalmology and Otolaryngology, "The Interpretation of Visual Fields," on page 14 are illustrated fields of bilateral homonymous hemianopsia due to occlusive vascular disease which are similar to those in my case, so undoubtedly other cases have been seen and not reported.

CASE REPORT

History. This patient, H. P., aged 61 years, was first seen by me on November 29, 1947, at which time he stated that he could not get around too well because of poor and restricted vision. His history was that on November 11th at 7 P.M. he developed a pain in the left side of his head and sudden loss of vision which gradually recovered. At 11 o'clock that same night, the head pain recurred, more generalized, and vision became blurred and has remained so ever since. He had particular difficulty in seeing to the side, so that he bumped into objects, especially those on his right side. He had been weak and bedfast until a day ago. He also stated that for several years he has been under the care of the referring physician for high blood pressure and arteriosclerosis.

Neurologic examination disclosed some spatial disorientation and some personality

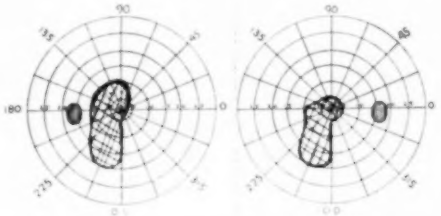

Fig. 1 (Ross). Field taken on November 29, 1947, with 6/1,000 white. Vision: O.U., 20/20.

changes. His general medical checkup revealed only an essential hypertension of 170/120 mm. Hg. All laboratory studies were normal as were skull X-ray studies.

Ophthalmoscopic examination revealed poor convergence. Relative visual acuity was: O.D., 20/200, 24-point type at 14 inches; O.S., 20/100, 18-point type at 14 inches; (correctible to normal for near and far). Refraction showed: O.D., +0.5D. sph. ⊃ −0.75D. cyl. ax. 100°; O.S., +0.5D. sph. ⊃ −0.75D. cyl. ax. 80°; (add: +2.25D. sph.).

Ophthalmoscopy revealed an angiosclerosis, Grade 2, O.U. The early visual fields were as in Figure 1. Later, June 21, 1948, small islands appeared up and to the left in each field as shown in Figure 2.

The patient had some spatial disorientation, not severe, and his wife stated some

personality changes, but no alexia. Opticokinetic nystagmus was elicited with ease but there were no spontaneous nystagmus and no reading disabilities. There were two degrees of fusion but tests for stereopsis gave variable findings. The diagnosis entertained was bilateral occlusion of portions of the posterior cerebral arteries (calcarine?) and Dr. P. R. McDonald in a personal communication stated he believed this case might well fit into this category.

For discussion of the anatomy, physiology, and other interesting aspects of these cases, reference is made to Dr. McDonald's paper in which the subject is so clearly discussed. This case differs from McDonald's in that

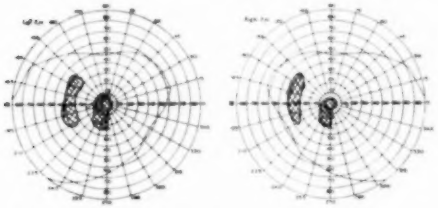

Fig. 2 (Ross). Field taken on June 21, 1948, with 6/1,000 white. Vision in both eyes was normal for far and near.

stereopsis was variable and spatial disorientation was present for a few months with recovery at the time of the last fields on June 21, 1948. The fields showed some peripheral recovery. Admittedly, as in McDonald's case, the exact anatomic diagnosis in this case can be made only at autopsy.

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DIABETIC RETROBULBAR NEURITIS

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Recently Walsh[1] said that he had no "useful evidence to offer on the validity of diabetic retrobulbar neuritis as a diagnosis" and suspected "that it rarely is a correct one." The basis for this was the failure of Waite and Beetham[2] to record any cases of retrobulbar neuritis in 2,000 diabetic patients.

Fuchs,[3] in 1894, mentions "cases of chronic poisoning by diabetes" as leading to retrobulbar neuritis. De Schweinitz[4] writes of diabetic amblyopia as being the only symptom of diabetes, of having a central color scotoma, and of being more apt to be found in diabetics who use tobacco freely than in those who are abstaining. Also, Berens[5] points out that, since diabetics are more susceptible to tobacco amblyopia than healthy individuals, some writers have thought that it was this association which was responsible for the signs of retrobulbar neuritis in diabetics. Berens states further, however, that well-substantiated cases have been seen in patients who were not exposed to poisoning by tobacco in any form.

Duke-Elder[6] states that, although it has not always been clear that the retrobulbar neuritis is not due to poisons such as alcohol and tobacco, so many instances have occurred wherein other poisons can be excluded that the existence of the condition as a diabetic complication must be admitted.

Traquair[7] reveals that, (1) In many of the reported cases the diabetic origin of the amblyopia is not convincingly demonstrated; (2) in cases of general disease, such as diabetes, in smokers one would be correct in most cases in attributing the amblyopia to the tobacco if the scotoma is typical and, in any case, the causation of scotoma by endogenic toxins in diabetes and other diseases, although extremely rare, must be borne in mind; (3) cases of pure diabetic toxic amblyopia have not hitherto been sufficiently closely examined in sufficient number to establish the true characters of the field changes, (4) the defect due directly to the toxins of diabetes is multiform and often pericentral and varying in shape.

REPORT OF CASES

Several cases of diabetic retrobulbar optic neuritis have been observed and are being

reported. In these, toxicity from tobacco, alcohol, teeth, sinuses, tonsils middle ear, and so forth have been definitely excluded.

Case 1. S. M., a 53-year-old woman, was seen on March 20, 1948, with a complaint that three weeks previously there occurred a gradual onset of loss of vision in both eyes. At that time a blood sugar of 262 mg./cc. was discovered and diabetic treatment instituted.

At the time of the ocular examination, the blood sugar was normal. Visual acuity with and without correction was 20/80 in the right eye and 20/100−1 in the left eye. Fundus examination except for slight A.V. compression was normal. The tangent-screen visual field showed enlarged cecal areas, and with a 1-mm. white test object pericentral scotomas, one degree in circumference in the right eye and two degrees in the left eye.

Case 2. H. E. a woman, aged 62 years, was seen on June 4, 1948. Six months previously, a blood sugar of 450 mg./cc. was registered, at which time there was marked "smokiness" of vision. The blood sugar was normal at the time of the examination.

Visual acuity without correction in the right eye was 20/200 and, with correction, 20/70; in the left eye, 20/100−1 and 20/60, respectively. The fundus showed a few scattered retinal hemorrhages, the maculas being clear. The tangent-screen field showed, in the right eye, a slightly enlarged cecal area and with a 2-mm. white test object a 4-degree pericentral scotoma; in the left eye a slightly enlarged cecal area and a 1-degree pericentral scotoma with a 2-mm. white test object.

Case 3. B. W., a 47-year-old woman, was seen on April 4, 1948, in the hospital complaining of blurring of vision. Blood sugar was 385 mg./cc. One week later when the ophthalmic examination was performed, the blood sugar was 180 mg./cc.

Vision with and without correction was 20/30 in the right eye and 20/40 in the left eye. Except for several pin-point retinal hemorrhages, elsewhere than in the macular area, the fundi were normal. Fields revealed enlarged cecal areas in both eyes, and with a 1-mm. white test object pericentral scotomas in both eyes, one degree in the right eye and three degrees in the left eye.

Discussion

That diabetic retrobulbar optic neuritis exists would seem to be unquestionable. Several such cases are presented; in these, other toxic elements, both endogenous and exogenous, have been eliminated.

Regarding diabetes, certain deplorable facts exist. For one, not all ophthalmic textbooks list diabetes as an etiologic factor. Secondly, referral of diabetics with early visual symptoms to an ophthalmologist occurs infrequently; there seems to be still an adherence to the old axiom of delaying until the general condition improves before an ophthalmic consultation is requested. It is likely that for the latter reason the incidence of diabetic retrobulbar neuritis lacks prominence.

Walsh[8] states that "obviously a fact of great clinical importance is that, if a patient complains of blurring of vision of recent onset, which is corrected by a change in lenses, the possibility of diabetes mellitus being causative should come to mind." Likewise, a case of blurring of vision in a diabetic should suggest retrobulbar optic neuritis.

Conclusion

The occurrence of diabetic retrobulbar optic neuritis as a clinical entity should not be questioned.

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A NEW HAND-SLITLAMP*

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This new slitlamp is similar in principle to units previously reported by me.† It is not designed to replace my previous models but to show individual structural and optical features. These are: first (1) The use of a simple pencil flashlight type of battery holder to provide a flexible grasp in manipulating and in rotating the slitbeam; (2) a selective interchange of either batteries or house current with rheostat control; and (3) an improved lens-cap unit to provide a more intense and satisfactory slitbeam.

Optically, this unit consists of a straight filament lamp similar to the one used on a streak retinoscope, except that the dome of the filament was made rectangular instead of arch-shaped. Over this is fitted a condensing system consisting of a pair of plano-convex lenses, each of 11-mm. focal length. These lenses are arranged in series fashion so that the convex surface of one lens faces the plano-surface of the other, and are separated by an air space amounting to as little as 0.6 mm. The combined focal length of this condenser lens system is 5.9 mm. This lens arrangement has proved more satisfactory than the simple hemispheric condenser employed in a previous model because it provides a brighter and more clean-cut slitbeam. The slitbeam represents the image on cross section of the top of this filament when brought to the focus or conjugate focus of this condenser lens system (fig. 1).

Structurally, the lamp portion of this unit consists of a tubular battery-type handle on which is fitted a specially designed housing to hold a miniature lamp surrounded by a

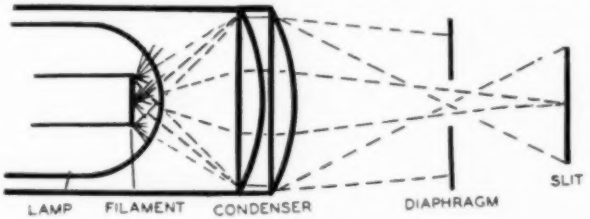

Fig. 1 (Krimsky). Optical bases for slitbeam.

Fig. 2 (Krimsky). Hand-slitlamp disassembled to show component parts.

* Presented before the American Academy of Ophthalmology and Otolaryngology, Chicago, Illinois, October 12, 1948.

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———: A featherweight slitlamp. Arch. Ophth., **21**:1033-1035 (June) 1939.

rotating cylindrical collar. The bulb remains fixed, whereas rotation of the collar through a helical arrangement draws it away from the handle without disturbing the fixed position of the bulb. The condenser lens cap housing fits snugly over this rotating collar so that both components rotate as a single unit. Such rotation serves to move the condenser lens system away from or toward the bulb which remains fixed during said operation. By greater separation of condenser and bulb, the size of the slitbeam becomes shorter and narrower and the operating distance is likewise correspondingly reduced (fig. 2).

Inspection of the eye is obtained selectively by means of a monocular magnifying loupe with collar which slides over the tubular handle. Also, one may operate this lighting system independently at any angle with the aid of a Beebe loupe or other type of magnifying lens system. The lens bracket is so designed and angulated that at the focal length of the viewing lens, the slitbeam is found to be in focus as well as in the center of the viewing field.

The slitbeam can be rotated to provide a vertical, an oblique, or a horizontal beam merely by rotating the lamp housing in this supporting lens bracket collar. By rotation of the lamp collar the slitbeam can be transformed to a broad or almost circular area of light. The supporting lens bracket has a spliced collar which fits over the battery holder, and can thereby be easily slipped off and transferred to any type of flashlight holder using 915 AA small-type Eveready batteries. While the bracket here shown provides for a fixed angle between lens and light, I am having constructed a flexible bracket which will enable ready adjustment to variable angles between lens and light source.

745 Eastern Parkway (13).

HERPES ZOSTER OPHTHALMICUS

Initiated by keratitis

Mark Thumim, M.D.
Middletown, Connecticut

This case is reported because of the rarity of the order in which the lesions appeared. Edgerton* could find only six cases in the literature in which the keratitis preceded the cutaneous eruption. Most of the cases which he found were reported many years ago. There have been, as far as we could find, no cases reported since Edgerton's paper.

Case report

History. Mrs. M. P., a 47-year-old white woman, was seen on August 11, 1948, with the complaint that, three days before, her left eye had become red, and that she had itching and a scratchy feeling in it as well as much lacrimation from it.

On examination, with oblique illumination, an area of corneal infiltration was seen at the limbus from the 1- to 3- o'clock positions. On August 12th, she began to have severe pain over the left side of her forehead and on the next day a rash appeared. When she was seen on that day, she had severe pain and she had vesicles on red bases on the lateral portion of her left upper lid, at the base of the nose to the left of the midline, and over the left part of the forehead. Corneal infiltration was still present.

She was seen again on August 18th, at which time no change was noted except that the left upper lid was swollen. On August 23rd, the pain was much relieved; the vesicles had dried; there was no change in the cornea.

On September 18th, the cornea was examined with a slitlamp and two areas of infiltration were seen. One of these was kidney-shaped and at the location of the infiltration originally noted. It was composed

* Edgerton, A. E.: Arch. Ophth., **34**:40-62 (July) 1945.

I wish to acknowledge the aid of Dr. William M. Joyce and Dr. C. C. Chase in studying this patient.

of discrete opaque dots in the stroma. A second similar lesion, round, was just medial and caudad to the first. The vesicles had dried up and had been replaced by pitted areas in the skin.

Comment

This case is reported because of the extreme rarity in which the keratitis appears before the neuralgia or the vesicles in herpes zoster ophthalmicus. In this case the eye symptoms were present for four days before the true nature of the disease was evident. This is in contrast to the usual picture of this disease in which the neuralgia is followed by the skin vesiculation and which in turn is followed by eye symptoms and signs.

Professional Building.

THE POSSIBLE OCCURRENCE OF BACTERIUM ANITRATUM IN SEVERAL CASES OF CONJUNCTIVITIS*

W. A. Moor
Saint Louis, Missouri

The following note is prompted by the recent publication of the description of a bacterium isolated, in most instances, from infectious conditions of the genito-urinary tract (Schaub and Hauber, 1948†). This bacterium is identical with a bacillus that has been found in several severe conjunctival infections, in so far as morphologic, cultural, and colonial characteristics are concerned.

Symptoms

For the past seven years an occasional conjunctivitis has been encountered that has presented some rather puzzling features. These cases (there have been 15 from which the organism has been isolated) have all started in one eye as an itching sensation and have developed over a period of 3 to 4 days to an appearance that is quite alarming. This progress has always continued at about the same rate regardless of what form of therapy has been tried (except for three cases in which streptomycin was used).

After this initial period of about a week or a little less, the other eye has usually undergone the same course. There is usually a great deal of injection of the blood vessels in the conjunctiva, a considerable edema of both the upper and lower lids, a moderate amount of irritation (however not as much as one would expect from the appearance of the eyes).

In three cases, there has been some swelling of the preauricular glands, somewhat more pronounced on the side of the eye showing the infection first. With most of the cases there has been a watery discharge but this has not been nearly as great in volume as would be expected from the appearance. There has never been any corneal involvement of any kind and, after 2 to 3 weeks, the inflammation has gradually subsided with no apparent after-effects.

It will be noted that this description could be thought to resemble very slightly the picture of a mild attack of epidemic keratoconjunctivitis; that there is a resemblance is shown by the fact that, on two occasions, tentative diagnoses of epidemic keratoconjunctivitis were made.

Cultures

Cultures taken from these patients have always yielded a rather scanty growth (only one case showed as many as 20 colonies) of an organism that is rather slow-growing on the plate of initial isolation and on the medium that is used for routine eye cultures (2-percent tryptose, 2-percent agar, 0.5-percent sodium chloride, 0.2-percent dextrose, and 5-percent defibrinated whole rabbit blood). Subcultures on the same medium have given very good growth.

After about 20 hours' incubation at 37°C., the colonies as first isolated are quite small (about 0.1 mm. in diameter) and of a very

* From the Department of Ophthalmology, Washington University School of Medicine and the Oscar Johnson Institute.

† Schaub, I. G., and Hauber, F. D.: Biochemical and serological study of a Gram-negative bacilli from human sources. J. Bact., 56:379 (Oct.) 1948.

light grayish or white color. After 40 hours' incubation, the colonies are usually from 0.2 to 0.3 mm. in diameter and the gray-white color is more easily determined. Smears made from the conjunctiva or from the 20-hour culture will show Gram-negative bacilli, the majority of which will be so short that they may be easily mistaken for cocci. Longer incubation and subcultures bring out the true bacillary shape.

Since 1942, we have had 1 or 2 cases each year from which this organism has been isolated. There are two exceptions to this incidence. In 1944, there were six cases. However, 4 of the 6 were patients who had been examined by the same physician using the same clinical facilities for each patient. The period over which these six cases extended was about six weeks.

These facts would seem to indicate that the organism is moderately infective and that the human incubation period is in the region of 2 to 4 weeks. That the organism is only moderately infective would seem to be indicated by the fact that, during the period under discussion, this physician had been seeing a great many patients and had been using the same facilities for each.

In 1948, there were four cases from which this organism was isolated. One of these cases was a true epidemic keratoconjunctivitis and possibly represents a mixed infection, two cases were tentatively diagnosed as epidemic keratoconjunctivitis by two different physicians but did not have corneal infiltrates, the fourth case was not diagnosed.

Treatment

In all four of these cases, after the organism had been identified, streptomycin was administered, and they showed almost immediate improvement. The improvement in the one case of true epidemic keratoconjunctivitis was, of course, only to the degree that resulted in the elimination of the secondary infection.

Tests with streptomycin

During 1947, after streptomycin had become readily available, the organism was isolated from a case of conjunctivitis that had been resisting treatment with both sulfathiazole and penicillin ointments. This strain was tested for in-vitro susceptibility to the routine antibiotics used in the eye clinic and was found to be resistant to 5-percent sulfathiazole ophthalmic ointment, 10-percent sodium sulfacetamide ophthalmic ointment, and calcium penicillin ophthalmic ointment (1,000 u. per gm.). It was susceptible to 100 mg. streptomycin to 1 cc. saline and 10 mg. streptomycin to 1 cc. saline.

The tests were simply to supply an indication for a possible treatment and were very crude. The organism was seeded on a plate, incubated to dry the surface, and 0.1 cc. of the agent on a cotton swab was drawn lightly over the seeded surface. The plate was then incubated overnight and observed the next morning for inhibition of growth both at the site of the streak and on the adjacent areas.

The patient from whom this strain had been isolated was treated with streptomycin (100 mg. to 1 cc. saline). Drops were instilled every three hours. Improvement was noted on the second day of treatment.

In three cases treated with streptomycin in 1948, a solution of streptomycin containing 1 mg. to 1 cc. of saline was used, and the instillations were made every two hours. Improvement was more prompt.

Animal experiments

The strain isolated in 1947 was suspended in saline and instilled into the conjunctivas of two rabbits and one cat that were prepared for the instillations by light abrasion with sandpaper. The two rabbits showed some moderate inflammation which started on the fourth day, lasted for about four days before it began to clear, and continued uneventfully for another two days. After this time, no signs of any kind could be seen. The cat showed nothing. The organism was not recovered from any of the animals.

It is hoped that serologic comparison with Bacterium anitratum will be possible.

640 South Kingshighway (10).

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

January 3, 1949

DR. BENJAMIN ESTERMAN, *president*

RECENT DEVELOPMENTS IN TONOMETRY

DR. ADOLPH POSNER discussed this subject during the instruction period.

ORBITAL TUMORS

DR. RAYMOND G. INGALLS said that an examination of all the orbital tumors in the Pathology Laboratory of the Institute of Ophthalmology of the Presbyterian Hospital revealed the following data.

They comprise a total of 216 tumors, divisible into 27 different groups, including specific cell-type tumors, and allied pseudotumors.

Their relative frequency is as follows: (1) angioma, 35; (2) pseudotumor (lymphogranuloma), 29; (3) lymphosarcoma, 22; (4) dermoid cyst, 20; (5) carcinoma, extension from accessory nasal sinuses, 16; (6) carcinoma, lacrimal gland, 7; (7) retinoblastoma, 12; (8) meningioma, 10; (9) melanoma, 9; (10) neurofibroma, 8; (11) carcinoma, extension from lids, 6; (12) cholesteatoma, 6; (13) rhabdomyosarcoma, 4; (14) neuroblastoma, 3; (15) carcinoma, metastatic, 3; (16) hematoma, 2; (17) myoblastoma, 2; (18) fibroma, 2; (19) osteoma, 2; (20) neurinoma, 2; (21) chondrosarcoma 1; (22) embryonal myosarcoma, 1; (23) neurosarcoma, 1; (24) leiomyosarcoma, 1; (25) lipoma, 1; (26) dermolipoma, 1; glioma (astrocytoma), 1.

The following list shows the age at onset for the youngest and oldest patients:

Angioma from birth to 65 years; pseudotumor, 9 to 74 years; lymphosarcoma, 1 to 77 years; dermoid cyst, 3 to 36 years; retinoblastoma, 2 months to 4 years; meningioma, 12 to 58 years; melanoma, 47 to 65 years; neurofibroma, 1 to 39 years; cholesteatoma, 37 to 63 years; rhabdomyosarcoma, 4 to 13 years; neuroblastoma, 8 months to 3 years; hematoma, 15 to 45 years; myoblastoma, 36 to 40 years; fibroma, 17 to 75 years; osteoma, 16 to 44 years; neurinoma, 7 to 15 years; chondrosarcoma and embryonal myosarcoma, infants; neurosarcoma, 7 years; leiomyosarcoma, 34 years; lipoma, 25 years; dermolipoma, 43 years; glioma, birth.

In the carcinoma group the following ages at onset were observed: Carcinoma, extension from accessory nasal sinuses, 50 to 70 years; carcinoma, lacrimal gland, 21 to 73 years; carcinoma, extension from lids, 58 to 77 years; and carcinoma, metastatic, 52 to 63 years.

Having established a table for age at onset, we may show the incidence of new growths for each decade: second, 12; the third, 16; fourth, 21; fifth, 28; sixth, 31; seventh, 15; and eighth, 9.

The first decade shows the following incidence: first year, 19; second, 5; third, 11; fourth, 6; fifth, 2; sixth, 2; seventh, 2; eighth, 2; and the ninth, 1.

This data may now be combined in the construction of a table of some value in differential diagnosis of tumors for each decade. For instance, we may list the tumors in the order of their relative frequency in a vertical column and then place the incidence figure of each tumor for each decade in adjacent horizontal columns. To make use of the table, we consult the decade column nearest the age of the patient and read down. For example, a patient between the ages of 40 to 50 years could have 1 of 11 different

types of orbital tumor, the possibility being angioma, 8; lymphosarcoma, 3; pseudotumor, 3; meningioma, 5; hematoma, 1; osteoma, mixed tumor of the lacrimal gland, 4; myoblastoma, 1; cholesteatoma, 2; dermlipoma, melanoma, 1.

Discussion. Dr. Knapp asked whether, in the presence of orbital tumors or exophthalmus, was any glaucoma noticed.

Dr. Kestenbaum said that Dr. Ingalls did not mention mucocele of the frontal bone in his very complete and comprehensive report, probably because it is not a real tumor. Dr. Kestenbaum also said that Dr. Ingalls did not mention symmetrical and asymmetrical exophthalmos, that is the eye can also be displaced to one side or the other. He felt that Dr. Ingalls's material provided a basis for study as to whether such displacements can be used in differential diagnosis. He suggested that further study might be worthwhile.

Dr. Smith asked about the apparent predilection of these tumors to the left orbit.

Dr. Ingalls replied to Dr. Knapp that glaucoma has no relationship to tumors of the orbit except in neurofibroma with infiltration of the posterior ciliary nerves with buphthalmus. To Dr. Kestenbaum he answered that mucoceles were purposely omitted from this listing. To Dr. Smith he said that it is not known why tumors of the left orbit are more frequent. Cushing had suggested that this may be because the left carotid has a direct route to the eye.

Measurement of Relative Exophthalmos by Roentgenography

Dr. Benjamin Friedman presented a method of measuring relative exophthalmos by means of X rays. The patient lies on the X-ray table, with eyes looking straight upward; a contact lens carrying a small lead dot is placed over each eye; the X rays are directed from the foot end of the table so that the central ray passes through the lead dots at an angle of 35 degrees with the table; the shadows of the lead dots fall upon the film. If one eye protrudes more than the other, the dot on the relatively exophthalmic eye will be projected farther back than the dot on the less protruding eye.

The chief problem is to position the eyes in space in such a manner as to eliminate sources of error, and to permit duplication of this spatial position each time an exposure is made. Steps in the procedure designed to achieve these ends were detailed.

Film measurements are made by dropping a perpendicular from the center of each dot shadow to the proximal edge of the film. The longer perpendicular belongs to the relatively exophthalmic eye. For practical purposes the difference in the length of these perpendiculars represents the relative exophthalmos, magnified four times.

The contact glasses are standard plastic lenses, with a central lead dot 1.5 mm. in diameter. The dots are placed over the pupillary centers. The lenses are handled with the usual suction grip. No fluid is needed between cornea and lens. One drop of anesthetizing solution is sufficient.

Readings in successive examinations may vary from 0.0 to 0.5 of ocular position. This, in most cases, is less than the variations found in repeated reading with the exophthalmometer.

The method measures relative, not absolute exophthalmos. For example, if both eyes were equally exophthalmic, there would be no unequal projection of the respective shadows. No dependence is placed on the distance of cornea from orbital margin. Horizontal as well as anterior deviations may be recorded.

Dr. Friedman concluded that this method cannot be expected to supplant instrumental exophthalmometry but it offers additional information. The two methods should supplement and check each other.

Discussion. Dr. Saskin asked how a norm is established.

Dr. Esterman said that, since the patient's

head is kept constant, it might be of help to place a lead dot on the brow, to give the increase of the exophthalmos on subsequent examinations.

Dr. Kestenbaum said that Dr. Friedman was using a new principle in exophthalmometry, since he uses the position of the entire head or, to be more exact, the position of the occiput and the two ear ducts as points of reference. Hertel's exophthalmometry measures the position of the cornea in relation to the two lateral orbital margins; Kestenbaum's ruler-exophthalmometry uses the two superior orbital margins as points of reference. Each of these methods is based on a different principle. The use of all three methods and comparison of the results may make us more independent of the individual variations.

Dr. Friedman replied to Dr. Saskin, that there is no need to establish a norm since each patient is his own norm. To Dr. Esterman, he replied that the lead dot was a good idea, and that he had used it. Dr. Friedman said that it acted as a center pivot from which the lateral displacement of the eyes can be measured. To Dr. Kesterbaum, he answered that any method to determine exophthalmos requires determination of what plane is to be used for measurement. In this case the plane cutting through the auditory canals is used. Overdevelopment of one part of the head can be determined by clinical examination, which should supplement the X-ray findings.

Angiographic diagnosis of orbital tumors

Dr. Antonio Grino presented a paper on this subject, which was published in full in the American Journal of Ophhtalmology, volume 32, page 897, July, 1949 (with Dr. Edwin Billet).

Discussion. Dr. Samuel Gartner said that this is an important presentation as it gives us a splendid additional technique for the study and diagnosis of orbital tumors. This is a puzzling group of diseases and we certainly need more help in their diagnosis. Exact localization in the orbit is important since a decision can then be made whether the ophthalmologist should remove the growth by the orbital route or whether a neurosurgeon should operate by the transfrontal approach.

Dr. Knapp said that he believed that the ophthalmic surgeon could deal with most cases of orbital tumor. He asked why, in the first cases presented, X-ray therapy was preferred instead of surgery.

Dr. Kestenbaum said that he had seen the first of the cases presented by Dr. Grino several years ago and again about one year ago. The latter examination revealed, in addition to the severe exophthalmos, damage to the central vision and a definite temporal hemianopic defect in the visual field of the right eye. Although the exophthalmos indicated a space-taking process in the orbit, the temporal hemianopic defect hinted at a lesion in the chiasmal region, therefore in the middle fossa of the skull.

At the Montefiore Hospital an angiography was done which demonstrated the presence of an angioma in the orbit. A renewed examination of the angiogram revealed the additional presence of an angioma in the middle fossa. This additional finding made the clinical and angiographic findings congruent.

Dr. Rizzuti asked whether stereoscopic X-ray examination was done.

Dr. Billet replied to Dr. Knapp's question, that X-ray therapy was tried first and, if it was not successful, surgery was then used. However, in this particular case X-ray therapy was very successful.

Dr. Grino replied to Dr. Rizzuti that stereoscopic X-ray examination is done routinely in all cases of this type.

Bernard Kronenberg,
Recording Secretary.

CHICAGO OPHTHALMOLOGICAL SOCIETY

November 15, 1948

DR. A. C. KRAUSE, *president*

(Presented by the Department of Ophthalmology, University of Chicago)

CLINICAL MEETING

SJÖGREN'S SYNDROME

DR. T. W. ANDERSON said that D. G., a 48-year-old white woman, was first seen at the University of Chicago Eye Clinic in August, 1948. She complained of episodes of burning and reddening of the eyes for the past 25 years. This had become worse during the past four years and constant during the past year. The eyes felt dry and sticky, sensitive to light, and vision was slightly hazy.

In 1940, the patient developed polyarthritis and swelling of the small joints of the hands and feet. In 1942, she had an episode of girdle pain lasting eight months, and lost 40 pounds. At that time an enlarged spleen was noted; there was no free acid in the gastric juice. She had been slightly anemic since the age of 15 years, for which she had taken liver and iron.

About this time she developed "chronic sinusitis" with postnasal drip. A turbinectomy had been done 22 years ago to help relieve the chronic episodes of conjunctivitis. In 1942 all the teeth were removed because of their poor condition; they had always been chalky. In 1946 she developed a salivary calculus of the right parotid duct followed by infection which drained externally below the right ear. Her mouth had been dry for 10 years and was now more so. In the same year a right mastoidectomy was performed. She developed thrombophlebitis in the lower extremities at this time.

Since adolescence she had had attacks of left pleurisy and, in 1947, a severe attack, of unknown etiology, developed; chest X rays at this time were reported normal. An infection of the left parotid gland, with associated skin infection of the face, was treated with streptomycin. Cultures of the conjunctivas, nose, and throat have revealed streptococcus; bacterial vaccines have given no relief. Local medication to the eyes has given only temporary relief at times.

The patient is a gaunt, slender woman who appears chronically ill. The skin is thin and atrophic, with brown patches on the lower extremities. There is generalized atrophy of the mucous membranes of the nose and throat, dryness, hyperemia, and patchy membrane. A thick mucoid substance was expressed from the sublingual salivary duct. The left parotid gland was enlarged, nontender, with a fibrous consistency. There were scars under the right ear and over the right mastoid. The mandible was slightly limited in action, with a dry clicking sound.

Eye examination revealed vision to be: R.E., and L.E., 20/30 with a 1-mm. pinhole. The skin of the lids was atrophic and dilated vessels were visible near the margins. The palpebral conjunctivas were injected and thickened; the bulbar conjunctiva was moderately injected, with slight superficial flush at the limbus. There was a thick ropy discharge in the lower fornix. The anterior surface of the corneas had patches of adherent thick mucoid material. There was central heavy punctate staining of the epithelium with 2-percent fluorescein and the epithelium was thinned and granular appearing. There were eight filaments standing by one end from the anterior surface of the right cornea. The Schirmer test was 0 mm.

On general physical examination the liver was lightly tender and enlarged two fingers below the costal margin. The spleen was very tender and enlarged four fingers below the costal margin. There was swelling of the wrist joints and fusiform swelling of the metacarpal and metatarsal joints, and some limited motion of the elbow joints. All laboratory tests were within normal limits with the exception that histamine gastric analysis

showed no free acid and scanty secretion; culture of the conjunctivas showed Hemolytic staphylococcus and C. xerosis.

This patient will be hospitalized for further study. At this time, the clinical impression is that she has keratoconjunctivitis sicca, syndrome of Sjøgren.

Healed luetic neuroretinitis papulosa

Dr. Paul G. Wolff said that this woman, aged 28 years, came to the clinic in October, 1946, with the complaint of poor vision in the right eye of one year's duration. One year before she had suddenly developed severe parietal headache, a generalized measlelike rash including the soles and palms, broad streaklike flashes of light, and a veil in front of the right eye. Her physician at that time told her she had secondary syphilis. Several weeks later the symptoms spontaneously subsided.

When first seen, vision was: R.E. 15/200 and could not be improved; L.E., 20/20+4, uncorrected. The optic disc of the right eye showed mild temporal pallor and an inferior temporal, dense, largely avascular connective-tissue proliferation. This tissue extended forward into the vitreous and was anchored to large retinal veins and several old chorioretinitic lesions. Peripheral fields were constricted. The left eye was normal.

The patient is still receiving antisyphilitic therapy and the Wassermann test is now negative. The eye status is the same.

This condition was first adequately described in 1926 by A. Fuchs, although previous accounts of the disease are mentioned in the literature.

Scientific meeting

Dr. Douglas Buchanan spoke on "Neurologic manifestations with optic-nerve atrophy in children."

Dr. Paul C. Bucy spoke on "Neurologic manifestations with optic-nerve atrophy in adults."

Richard C. Gamble,
Secretary.

Ophthalmic Miniature

Kepler's overwhelming astronomic discoveries overshadow his important contributions to our understanding of the process of seeing. He was a strange, erratic genius and his was a most unusual mind. In the discovery of the laws of the solar system an essential step was the emancipation from mechanical models. Kepler did not proceed by thinking out possible devices by which planets might be moved across the sky. He was guided by a sense of mathematical form, an aesthetic instinct for the fitness of things. In these later days it seems less incongruous that a planet should be guided by the condition of keeping the action a minimum than that it should be pulled and pushed by concrete agencies. Many of his contemporaries must have frowned on these rash adventures of scientific thought and felt unable to accept the new kind of law without any explanation or model to show how it could possibly be worked.

After Kepler came Newton, and gradually mechanism came into predominance again. It is only in the last years that we have gone back to something like Kepler's outlook, so that the music of the spheres is no longer drowned by the roar of machinery.

A. S. Eddington in *Naturwissenschaft*, November 14, 1930

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THE ACADEMY MEETING

The 54th annual session of the American Academy of Ophthalmology and Otolaryngology was held in the Palmer House, Chicago, October 9 to 14. It was one of the most successful meetings from many points of view.

The presence of Sir Stewart Duke-Elder, the guest of honor, was one of the chief attractions. He has won the hearts of his American colleagues by his scientific attainments and his many noteworthy contributions to our science. His textbook is a priceless heritage to present and future generations of English-speaking ophthalmologists everywhere. He has endeared himself to each of us by his open-handed friendship, sincerity, and great personal charm. His appearance at the meeting assured a happy and cheerful atmosphere which permeated all of the activities and dispelled for a little while the gloom of world troubles and the depression that accompanies the thought of socialized medicine.

As is usual, the multiple activities of the Academy occupied every single working hour, beginning early in the morning and extending far into the night. As one of our

witty members remarked, "the Academy meeting makes you take nembutal to sleep and benzedrine to stay awake."

The total registration topped all records; 4,848 members and guests arrived early and most of them stayed to the last minute of the last day. One-hundred-eighteen individual courses (including 12 home-study course discussion periods) and 30 continuous courses in ophthalmology, with a faculty of 175 instructors, totalling 376 hours of instruction, were eagerly attended. It would seem that every possible subject in ophthalmology was covered, with the heaviest interest and attendance in those subjects that offered clinical aids to the practicing physician. Nearly every course was sold out and the popular ones were packed to the doors.

Thirteen out of the 23 scientific exhibits were of ophthalmic interest and all were of high caliber. The exhibit, "Primary chorioretinal aberrations with night blindness," by Harold F. Falls, in collaboration with P. J. Leinfelder, David G. Cogan, Frank D. Carroll, and F. Bruce Fralick, justly received the first award; "Malignant melanoma of the uveal tract," exhibited by Helenor Campbell Wilder of the Armed Forces Institute of Pathology, with the collaboration of Lawrence P. Ambrogi, won the second award; and that of Samuel Gartner, with the collaboration of Abraham Schlossman and Edwin Billet, on "Ocular pathology in general medicine," was awarded the third ribbon. Many fruitful hours of study of these and the other exhibits amply repaid the keenly interested members and guests.

At the joint session of the scientific sections, the president, Conrad Berens of New York, spoke on "Research in otolaryngology and ophthalmology; The role of the American Academy of Ophthalmology and Otolaryngology." He pointed out the support that the academy has given to pertinent research in the past and emphasized its future influence in this field of activity. His figures showing that for every 70 dollars spent for the care of the blind, one dollar was spent for ophthalmic research and the prevention of blindness, were startling and depressing. He urged the formation of an international institute for the prevention of blindness and the conservation of sight, whose purpose would be to coördinate the efforts of the many organizations that are dedicated to saving sight. It would be most effective if established near the permanent headquarters of the United Nations in New York City.

Sir Stewart's address was on "The physiology of the intraocular fluids and its clinical significance." He summarized the present state of our knowledge of the subject to which he has contributed so much from his own researches in the past. His fluent style, his genius for collecting the essential facts, and his masterly presentation made a most difficult subject sound easy. He quoted Goethe to the effect that "hypotheses are cradle songs which lull to sleep" and added his own thought that, while this may be true, "if you sleep perchance you dream and may even awake to write a sonnet."

He then went on to develop a working hypothesis of the subject of the formation and disposal of the intraocular fluids so logically that time and future investigation will surely bear it out.

The remainder of the scientific papers were of remarkably high quality. The annual Edward Jackson Memorial Lecture was given by William L. Benedict of Rochester, Minnesota. His subject was "Diseases of the orbit." As is customary, the lecture will be printed in the JOURNAL and each reader will have the pleasure of appreciating its excellence.

The various ophthalmic symposiums, that are becoming the most important and attractive features of the scientific sessions, were unusually good. Space does not permit a detailed description and analysis of these symposiums, but it might be mentioned that the papers by John M. Sheldon, Ann Arbor, Michigan, on the "Immunologic aspects of allergy"; the entire symposium on "Primary chorioretinal aberrations with night blind-

ness," by the groups whose exhibit on the subject won the first prize previously mentioned, and the attractive discussion of it by Sir Stewart, who pointed out that, after listening to the papers, one can readily see that the biogenic stimulator treatment of retinitis pigmentosa is "no good"; and the thrilling and outstanding contribution of Albert B. Sabin of Cincinnati to the symposium on toxoplasmosis, appeared to excite the admiration and sustained applause of the members more than has ever been experienced before in any scientific session of the academy.

A feature, introduced at the last meeting, of beginning each session with a short clinicopathologic case report by an ophthalmic pathologist, is of such value and interest that it undoubtedly will become permanent. The case report by J. Clement McCulloch on the pathology of choroideremia was particularly worthy of attention. It disposes once and for all the controversy over whether or not atrophy of the choroid is actually present in this condition.

Among the remaining papers on the program, all of merit, that of Alan C. Woods on the "Use of antibiotics and sulfones in clinical ocular tuberculosis" was preëminent. One of our many guests from all over the world at the meeting, Dr. T. a'B. Travers of Melbourne, Australia, presented an important paper on the "Practical importance of abnormal retinal correspondence," and pointed out the value of operation in this condition as early as it can be recognized.

As is customary, motion pictures of ophthalmic surgery by various surgeons were interspersed here and there in the program and were excellently received.

The social aspects of the meetings likewise were a bit overwhelming. The event of primary interest was, of course, the banquet. It was so well attended that the members, their wives, and guests, overflowed onto the large balcony surrounding the ballroom, an unheard of proceeding. After the award of 14 honor keys, Sir Stewart spoke, at the top of his form, of the machinations of socialized medicine in Great Britain in such a way that even the discussion of this gloomy and unhappy subject could not dissipate the rosy aura of good fellowship and pleasure that surrounded the dinner party. At the conclusion of the dinner, Sir Stewart was awarded the plaque of the academy, signifying his honorary membership in the organization.

The hospital reunion dinners, all crowded, occupied the attention of the members, as is usual, on one of the evenings. A dinner for the exmedical officers stationed in the E.T.O. was obviously enjoyed and was graced by the presence of the erstwhile Brigadier Sir Stewart, a former comrade in arms to all of those present.

The smoker on another evening was so crowded that the floor space became smaller and smaller as new tables were added, thus increasing the pleasurable crowding together of the dancing couples. Before and after these and other events, one kept himself busy scurrying about from one cocktail party to another, in a sort of academy pub crawl.

The incoming president of the academy is J. Mackenzie Brown of Los Angeles, California. The following officers were elected: 1st vice-president, Edwin B. Dunphy of Boston, Massachusetts; 2nd vice-president, Kenneth L. Craft of Indianapolis, Indiana; 3rd vice-president, James Mason Baird of Atlanta, Georgia. Derrick Vail of Chicago was chosen president elect.

Derrick Vail.

RECOMMENDATIONS FOR PROTECTION OF PATIENT IN CONTACT-LENS FITTING

Under the heading "The contact lens problem," Conrad Berens, secretary of the American Committee on Optics and Visual Physiology, has written an article published in the *Journal of the American Medical Association* (*140:* 602-603, June 18, 1949), in which he discusses the fitting of contact lenses and

the recommendations made by the Committee on Optics, primarily for the protection of patients who desire contact glasses or for whom contact glasses are thought by their refractionists to be desirable.

The idea of lenses that can be worn in contact with the eyeball and the under surfaces of the lids is an old one. Dr. Berens states that it was first suggested by Sir John F. W. Herschel, a British astronomer, in 1827, and that, in the latter part of the 19th century, wearable lenses were made for pathologic conditions. In recent years much more satisfactory contact lenses have been manufactured and new modifications are continually being brought forward.

The Committee on Optics and Visual Physiology sent a questionnaire to 2,000 certified specialists of the American Board of Ophthalmology, asking their experience with contact lenses. Of 413 replying who had had experience with contact lenses, 373 preferred the molded plastic technique. The consensus was that the fitting of contact lenses was not without danger to the patient and should be performed by, or under the direct supervision of, an ophthalmologist. Corneal abrasions and corneal ulcers have resulted from the fitting and at least one case of a lost eye has been recorded.

The commonest motivation for the purchase of contact lenses is undoubtedly vanity, particularly the desire of young women with high myopia to be able to see clearly without glasses. There are, however, occupations, such as acting, dancing, war-time flying, in which the usual glasses are a serious handicap and contact lenses may be of immeasurable help. Ophthalmologists will invariably state that the great field for contact glasses is that of keratoconus. Fortunately, however, these cases are rare. Human nature being what it is, vanity will continue to influence many and the demand for contact glasses will not only continue, but will increase.

Ophthalmologists consider the fitting of contact glasses, especially the molded type in which anesthetizing drops are necessary, to be a medical procedure. Therefore, the American Committee on Optics and Visual Physiology, after a careful study of the situation in this country, has made the following recommendations which have been endorsed by the four national societies having representatives on this committee:

1. National and local ophthalmologic societies should regulate the prescribing of contact lenses and the dissemination to the public of information regarding contact lenses.

2. The prescribing and/or the fitting of contact lenses by persons not properly licensed under state or national laws should be prohibited.

3. Medical opinion should be obtained in every case before contact lenses are prescribed.

4. Ophthalmologists should establish standards for approving the qualifications of technicians who wish to engage in fitting contact lenses.

5. Competent impartial research should be initiated toward the solution of unsolved problems concerning contact lenses. The main problem at the present time, provided that the fitting of the lenses is correct, is that of hazy or cloudy vision. Blurring of vision occurs inevitably after wearing a contact lens for some hours because of the altered metabolism of the cornea.

6. The public should be warned against those who advertise the superiority of their services or of any particular type of contact lenses. It should be pointed out that the public should not patronize such advertisers because competent professional practitioners do not resort to commercial advertising.

Some of these recommendations are deserving of special comment. Recommendation 1 would require legislative action. The mere fact that ophthalmologists may consider that the prescribing of these lenses and the dissemination to the public of information on this subject should be regulated by ophthalmological societies will not necessarily bring this about. These activities will surely

not be so confined if manufacturers and dispensers of optical goods who deal directly with the public are not legally disbarred from performing these functions. In this, as in most health matters states are essentially autonomous and there are 48 of them so that it is always difficult to pass restricting legislation, particularly if strongly opposed. Such objection would be made especially by those who advocate and dispense contact glasses that can be fitted without anesthetics, such as small corneal discs or any other form that does not require molding.

Recommendation 2 implies that the prescribing and fitting of contact lenses should be treated as a specific activity and provides that only a well-defined group be permitted to perform this function. If new legislation were to be sought, this paragraph would have to be a part of it and would encounter opposition similar to that in Recommendation 1.

Recommendation 3 emphasized the ophthalmological opinion that fitting contact glasses is a medical problem, but does not specify that medical opinion must be obtained.

Recommendation 4 would place the certificating of technicians under the control of ophthalmologists, and put the burden of determining minimum standards for technicians on the doctors.

Recommendation 5 encourages further studies for improving contact glasses.

Recommendation 6 is an application of that part of Recommendation 1 referring to the dissemination to the public of information about contact lenses and their fitting.

In summary, the committee believes that control of the prescribing and fitting of contact glasses should be in the hands of physicians and that such laws as are necessary to accomplish this should be passed. This, as stated, is a large order, but suitable procedures should be initiated to bring these laws into being. This will require much effort on the part of many ophthalmologists.

It may be that most good will be accomplished by educating the public and utilizing to the full such existing laws as apply to this problem. New legislation, as pointed out, will surely be extremely difficult to pass and, if passed, to enforce. Existing laws generally prohibit the use of drugs by others than medical doctors. In the meantime, these laws should be strictly enforced. In the case of fitting contact glasses, it is not unusual for the technician to state that the physician has delegated to him or her the right to use drugs. No physician should ever assume such a power. He certainly does not have it legally and, since it is he that is legally responsible for any injury to his patient, he not only is acting illegally, but foolishly.

Generalizing further, these recommendations of the American Committee on Optics and Visual Physiology seem excellent suggestions for regulating the prescribing and fitting of contact glasses. If their intent is carefully followed, there should be a minimum of danger to the patient and there is a good possibility of continuing improvement in the construction of these lenses through well-directed research.

Lawrence T. Post.

Erratum

In our article in the American Journal of Ophthalmology, (32: 247, Part II, June, 1949), the first two columns of the Table 6 were incorrect (due to an error in the manuscript) and should read as follows:

Major Semiaxis (a in mm.)	Minor Semiaxis (b in mm.)
0.0346	0.00289
0.0316	0.00316
0.0283	0.00354
0.0224	0.00448
0.0173	0.00577
0.0141	0.00707
0.0130	0.00769
0.0100	0.0100

Only with these figures will the cross-sectional areas of the elliptical tubes be equal

while having largely different pressure drops.

(Signed) K. W. Ascher,
Cincinnati, Ohio.

CORRESPONDENCE

National Foundation for Eye Research

Editor,
American Journal of Ophthalmology:

An organization known as the National Foundation for Eye Research,* founded in Washington, D.C., proposes to raise funds for ophthalmic research. This foundation hopes to encourage public support for medical research aimed at discovering the causes for ocular diseases leading to blindness and at developing more efficacious therapies.

The National Foundation for Eye Research will differ in its operation from many organizations designed to further medical research in that its funds will not be restricted to the study of any one disease but will be used to promote research in the whole field of ophthalmic diseases.

The activities of the foundation will be limited entirely to supporting and establishing research centers for ophthalmology in various localities, leaving other approaches to the prevention of blindness and rehabilitation of the blind to existing agencies.

The need for an expanded research program is apparent when one considers that there are about 260,000 blind persons in the United States with 20,000 new cases added annually, and that the existing funds, facilities, and personnel available for ophthalmic research are pitifully inadequate to study thoroughly the basic causes of the diseases which result in blindness. For instance, there is less than $400,000 spent annually in the United States on medical research primarily designed to decrease the number of blind—less than 1 percent of that used for rehabilitation of those who have already lost their sight. Moreover, there are only about a dozen trained, full-time research men working in this field in the whole country, and few practicing ophthalmologists can devote a significant amount of time to research because of the restrictions of an active practice.

Mr. George Swartz, well known for his promotion of other medical philanthropies, has been selected as national chairman. With the assistance of a board of directors composed of prominent laymen, he will be responsible for the activities related to raising the necessary funds. The allocation of funds for research purposes will be made upon the advice of a scientific advisory board consisting of Dr. V. Everett Kinsey, chairman; Dr. Francis Heed Adler, Dr. Edwin B. Dunphy, Dr. Jonas Friedenwald, and Dr. Alan C. Woods.

It is hoped that ophthalmologists through their contact with the public will add their support to the group of laymen whose interest in expanding ophthalmic research has led to the formation of the National Foundation for Eye Research.

(Signed) Edwin B. Dunphy,
Boston, Massachusetts.

* Shoreham Building, Washington, D.C.

National Ophthalmological Society

Editor,
American Journal of Ophthalmology:

For some years past, Dr. Louis Bothman had been discussing the matter of the organization of a national ophthalmological society which would be truly representative of the ophthalmologists of the country.

There are other organizations in ophthalmology such as the Section on Ophthalmology in the A.M.A., and the Academy, which is eye, ear, nose, and throat, and the Association for Research. However, it would seem that a national ophthalmological society, in the same sense that such a professional and scientific organization exists in other fields, one that is truly representative of the best in ophthalmology, could materially help in raising the standards of ophthalmology in the teaching, clinical, and research fields.

It might be possible for such a society to undertake annual lectureships of outstanding quality as a regular part of its program, as well as the publication of an eye journal restricted purely to original contributions. Certainly there is room for such a publication in view of the length of time it takes for articles to be published at the present time.

As a personal friend of Dr. Bothman's for more than 20 years, I should like to help make his dream of such an organization become a reality.

(Signed) Samuel V. Abraham,
Los Angeles, California.

BOOK REVIEWS

REFRACTIONS. By Sir Stewart Duke-Elder. St. Louis, The C. V. Mosby Company, 1949. Price, $6.25.

The fifth edition of Duke-Elder's well-known textbook on refraction retains all the features which have made it one of the most popular authorities in the field and, at the same time, presents new and enlarged sections that bring the entire work up to the most modern conceptions. The introductory chapter, dealing with the philosophy of the symptoms and treatment of eyestrain, is particularly commendable for its effort to evaluate the relation of symptoms to errors of refraction. It is rightly emphasized that many errors do not require correction but that, when they do, accuracy is essential.

The discussion of the principles of physiologic optics as applied to the eye is naturally much more brief than that contained in larger works or in Duke-Elder's monumental *Textbook of Ophthalmology* but it would seem quite adequate for the purpose. Recent views on the biologic determination of myopia are discussed and material on transient changes in refraction is presented. New or amplified passages deal with anomalies of convergence, the streak retinoscope, velanoskiascopy, the mechanism of accommodation, and the effectivity and equivalence of lenses. Particularly notable is the amplified description of aniseikonia and of contact lenses.

As is characteristic of all of Sir Stewart's work, this book is written in an extremely clear and straightforward style. It is most difficult to find any fault with the factual material. Since there is a legitimate difference of opinion regarding the best method of refraction, especially as relates to the use of cycloplegics, many will not agree with the emphasis on the manifest refraction in young adults and early presbyopes but the views expressed are conservative and represent the practices in many offices and clinics.

William A. Mann.

DIE KLINIK DER LABYRINTHITIS UND PARALABYRINTHITIS AUF GRUND DES RÖNTGENBEFUNDES. By Prof. Dr. Med. Horst Wullstein, Stuttgart, Georg Thieme Verlag, 1948. Imported by Grune & Stratton, New York. 150 pages, 64 figures, bibliography. Price, $8.50.

Wullstein's monograph, a culmination of 10 years of work, presents a masterly study of the labyrinth in health and disease. The exquisitely clear skiagrams, with which it is profusely illustrated, are compared with anatomic sections and artistically clarified by accompanying sketches. This volume, which should prove invaluable to the roentgenologist, otologist, and others interested in this field, reflects the best traditions of German scholarship and publishing.

James E. Lebensohn.

DERMATOLOGIE FÜR AUGENÄRZTE. By Walter Schönfeld, M.D., Professor of Dermatology of the University of Heidelberg; Director of the University Clinic of Dermatology. Stuttgart, Georg Thieme Verlag, 1947. 104 pages, illustrations, 16 color plates, and index. Price, $7.25.

The volume is well organized, and the illustrations, particularly in color, are excellent. In a general introduction, some of

the principles of diatheses are outlined. There is a brief résumé of the technique of the patch and intracutaneous tests for allergic manifestations. The chapter dealing with treatment is rather incomplete since little but modifications of zinc and mercury preparations are enumerated.

Two main chapters are devoted to the discussion of individual forms of skin afflictions. The first deals with those of an infectious nature, and is subdivided into groups of unknown origin, parasites, and fungus and bacterial infections. The second chapter discusses dermatoses, avitaminoses, malformations, congenital diseases, and tumors. In closing, anomalies of the hair, the glands of the skin, and pigmentation are described.

It should not be expected in an outline of this scope that anatomic-pathologic details would be discussed at length. However, it is disappointing that ocular changes are only mentioned rather than described in any detail. For example, the conjunctival involvement in erythema exudativum multiforme is just listed as occurring in association with the general symptoms; no details are given. Equally unsatisfactory is the discussion of Boeck's sarcoid and tularemia; syphilis is all but omitted.

Because there is a close relationship between the two specialties, this little volume is worthwhile as a refresher course in dermatology for ophthalmologists. A treatise of this nature should represent a desirable addition to the literature, and it is to be regretted that Schönfeld has accomplished this only to a limited extent.

Stefan Van Wien.

TRANSACTIONS OF THE OPHTHALMOLOGICAL SOCIETY OF PARIS (and of the Ophthalmological Societies of the East, of Lyon, and of the West). August-September, 1948, pp. 405-529; October, 1948, pp. 532-694.

The session of June 13th was opened by a famous guest speaker, D. Cordier, who discussed the role of vitamins in the physiology of vision and in the metabolism of various structures of the eye. Van Canneyt and L. DeBaets made suggestions on the marking of the cylinder axis. P. L. Drouet and C. Thomas reported a detailed biochemic and etiologic study of Sjøgren's syndrome. J. Nordman's study on the treatment of strabismus dealt especially with the timing of surgery and a comparison of early surgery, as done in the United States, with late surgery, as favored in most European countries.

Cordier reported a case of acute glaucoma after intracapsular cataract extraction. Total iridectomy controlled the tension. E. Duhamel and Umbdenstock found a reacting pupil in a case of total blindness after embolism of the central retinal artery and discussed the function and location of the optic and pupillary fibers.

Thomas, Cordier, and Algan observed a patient with tuberous sclerosis who was simultaneously affected with band-shaped keratitis, a coincidence never before described.

At the meeting of June 21st, Beauvieux read an excellent pathologic and clinical review of glaucomatous cupping which emphasized the importance of vascular disturbances and ocular hypertension. A. Mercier achieved considerable local improvement in three cases of neuroparalytic keratitis with placental implants.

Le Jamtel read a paper on lymphoblastic sarcoma of the orbit and Offret and Hervoulet saw three patients with unusual pathologic changes at the posterior pole which simulated malignant lesions and which, after enucleation, proved to be inflammatory reactions.

In the October volume, P. Toulant and A. M. Larmande described the nervous and mental disturbances of sympathetic ophthalmia, probably encephalitic and meningitic in origin. The younger patients in this group had endocrine disturbances and the older

ones a hypercholesteremia. P. Bonnet suggested that a patient with the complications of sympathetic ophthalmia should not be deprived the benefit of surgery. In his hands, an intracapsular cataract extraction was successful.

A diagnosis of bilateral tuberculous tarsitis was made by Belz and verified by biopsy. Tarsectomy and diathermy coagulation were combined with calcium therapy. He also emphasized the value of Friedenwald's ophthalmoscope in the diagnosis of central serous chorioretinitis.

P. Bonnet saw a thrombosis of the central vein, which was formed by leukocytes and an unusual segmentation of white and red blood cells in the preretinal hemorrhage, in a severe case of leukemia.

L. Paufique described a new technique for the breaking of anterior synechias before completing keratoplasty. The place of trephination is outlined with a 6-mm. trephine, overlapping the anterior synechias by 2 mm. Sutures are applied at the edge of the disc and knotted so that they are in place for the traction to be applied later on. The cornea is only partly perforated by slightly inclining the trephine. The corneal flap is carefully raised with the traction sutures and the anterior synechia is removed with an iris hook and scissors. Of 8 operations of this kind, 5 were uneventful, 1 was complicated by a mild iritis, and 2 by an increase in tension.

Alice R. Deutsch.

SITZUNGSBERICHTE DER WIENER OPHTHALMOLOGISCHEN GESELLSCHAFT. By Dr. H. Fanta. Wien, Urban & Schwarzenberg, 1947.

The proceedings of the Vienna Ophthalmological Society cover in 98 pages the 23 meetings held between January 19, 1942, and February 26, 1945. A wide range of diseases, operations, and pathologic conditions of the eye are discussed. Many of the ideas expressed are widely known now and there is very little material relating to the war. An index by subjects and authors makes any comment easily found.

J. Böck, H. Fanta, K. Heinz, J. Meller, K. Lindner, A. Pillat, and R. Rössler are prominent among the contributors.

GAIL SOPER.

IL TRACHOMA. By Giambattista Bietti. Rome, 1947. 142 pages.

In this monograph, which was contributed as part of a program financed by U.N.R.R.A. to combat social diseases, Professor Bietti systematically considers the various aspects of the trachoma problem. He presents its history, discusses etiology and epidemiology, and adequately describes the manifestations of the diseases in the various tissues that are involved, the complications, pathology, diagnosis, prognosis, prophylaxis, and treatment.

F. H. Haessler.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Cooper S., and Daniel, P. M. **Muscle spindles in human extrinsic eye muscles.** Brain **72**:1-24, Jan., 1949.

With the demonstration of neuromuscular spindles in human extraocular muscles the authors have completed the chain of evidence that establishes an anatomical basis for proprioception in ocular motility. The orbital contents were removed soon after death in 60 individuals ranging in age from 82 years to newborn. The individual extrinsic eye muscles were dissected out, pinned on cork, and fixed in 10-percent formol-saline. The muscle spindle consisted typically of a group of fine cross-striated muscle fibers with a rich nerve supply in a thin torpedo-shaped capsule of fibrous tissue. The appearance is reminiscent of human fetal muscle spindles and suggests that the human eye muscle spindle may be a rather primitive form of this neuromuscular organ. The muscle spindles were found in the proximal third and at the proximal end of the distal third of the muscles, but not in the belly. The largest number of muscle spindles were in the inferior rectus. Muscle spindles have also been found in the extrinsic eye muscles of the chimpanzee, in certain ungulates (goat, deer), but not in the macaque monkey, dog, cat, or rabbit.

James E. Lebensohn.

Harms, J. W. **Transplantation of regenerative tissue into the anterior chamber.** Klin. Monatsbl. f. Augenh. **114**:298-308, 1949.

Autoplastic experimental transplants of young regenerative tissue from the tail or an extremity of Triton alpestris into the anterior chamber led to a dissolution of the lens and, in some cases, of the retina. After resorption of the implant a new lens was formed from the upper border of the iris. Experiments with tadpoles raised in thiourea showed inhibition of the organs of internal secretion with a disturbed development of the eyes such as exophthalmus, smaller bulbi, and reduction in the number of rods and cones.

Max Hirschfelder.

Moerike, K. **Comparative functional examination concerning the special thickness of the choroid in the macular region of the eye.** Klin. Monatsbl. f. Augenh. **114**:308-319, 1949.

The choroid has greater thickness in the macular region. This is shown by the author's measurements on slides from human eyes. In birds with formation of two maculas in one eye like the tern, a particularly well developed stretch of choroid is found under each macula. The metabolism of the rods and cones in these regions requires a greater blood supply and the greater thickness of the underlying choroid corresponds to this requirement. (References.) Max Hirschfelder.

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Bailliart, J. P. **The pathologic physiology of the corneal endothelium.** Ann. d'ocul. **182**:509-513, July, 1949.

Corneal endothelial cells are capable of being transformed into macrophages in the aqueous humor. In the cellular examination of the aqueous large cells of approximately 50 μ are not infrequent, with nucleii of 20 μ and granules of 5 to 7 μ. These cells frequently contain hematinic debris, leucocytes, iris pigment or even bacteria. The author has shown that these cells are directly derived from the corneal endothelium and considers that their phagocytic qualities are associated with senescence and inflammatory reactions. Chas. A. Bahn.

Cogan, D. G. **Vascularization of the cornea. Its experimental induction by small lesions and a new theory of its pathogenesis.** Tr. Am. Ophth. Soc. **46**: 457-471, 1948.

After small experimental lesions in the cornea of the rabbit a sequence of events leading to new bloodvessel formation occurred with remarkable regularity. After a latent period the proximal vessels, chiefly the venules and capillaries, became engorged and saccular aneurisms developed. These aneurisms burst, caused hemorrhage into the corneal stroma and became deflated. The hemorrhagic area then became riddled with new capillaries, most of which receded in a few days, leaving loops directed toward the lesion.

Interstitial vascularization of the cornea occurs when compactness of the cornea is reduced in the region of pre-existing vessels. David O. Harrington.

Fazakas, S. **The role of Penicillium species in fungus and bacterium cultures.** Szemészet **2**:69-73, 1949.

Since 1931, the author continuously examined the fungus flora of eyes. One third of the fungi found were Penicillium species. In mixed cultures consisting of Penicillium and another species such as fission fungi, Aspergilli, Periconia keratitidis, Microsporon felineum, and Trichophyton, it was mainly the Penicillium that inhibited bacterial growth. In the mixed cultures containing Penicillium and Actinomyces the inhibiting effect was nearly equal. Many cases of symbiosis and neutrality also were observed between Penicillium and other fungi or bacteria.

Gyula Lugossy.

Letterer, Erich. **Ophthalmology from the viewpoint of general and experimental pathology.** Klin. Monatsbl. f. Augenh. **114**:289-298, 1949.

The many and varied problems of general pathology which are illustrated by clinical or experimental findings in the eye are reviewed. Phenomena of normal and disturbed circulation can be observed at the limbus, and hemodynamic disturbances during experimental collapse in the retina. In angiospastic retinopathy, dystrophic cell damage is the result of disturbed circulation with deposit of fat and lipoids in the tissues. Storage of lipoids and phosphatids in cells is a characteristic finding in Tay-Sachs and Nieman-Pick disease. Deposit of amyloid in the ocular

tissues is rare. The avascularity of the cornea is the basis for a particular course in inflammatory processes. Hyperergic inflammatory reaction and elective sensitizing of tissues are demonstrated in interstitial keratitis as well as in sympathetic ophthalmia. Max Hirschfelder.

Marchesani, O. **The problem of the endogenous inflammations of the eye.** Arch. f. Ophth. **149**:69-94, 1949.

The frequency of keratoconjunctivitis eczematosa, endogenous uveitis and periphlebitis retinae are studied with respect to age and sex of patients afflicted with one or the other of these conditions. Keratoconjunctivitis eczematosa occurs most often in children under five years of age. Endogenous uveitis and periphlebitis retinae reach their maximums for people between 20 and 25 years of age. The keratoconjunctivitis is correlated to the so-called exudative lymphatic diathesis. Foci of lymphatic disease, especially of the glands of Waldeyer's ring of the throat, irritate the vegetative nerves of the cornea and conjunctiva and make these tissues vulnerable. A special type of endogenous uveitis is found in women during the menopause. Acute uveitis is more often seen in men, chronic uveitis somewhat more often in women. Periphlebitis prevails in young men and seems often to be combined with disturbances of the endocrine glands. Ernst Schmerl.

Meves, H. **The elastic structure of the ocular bloodvessels.** Arch. f. Ophth. **149**: 275-281, 1949.

This is a second contribution dealing with this problem. Twelve retinal gliomas were studied. In the majority of the vessels the elastica was lost. The main branches of the arteries of the glioma were often found dilated and hyperplastic. The hyperplastic parts of the bloodvessels of retinal origin showed the structural peculiarities described before. In 8 to 12 choroidal sarcomas an elastica was present. Ernst Schmerl.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Auricchio, G. **Permeability of the lens-capsule for glucose after paracentesis.** Boll. d'ocul. **28**:161-168, March, 1949.

Rabbits' eyes were punctured three times at 48-hour intervals; 18 hours after the last paracentesis the animals were exsanguinated and the lenses examined. Some of the lenses were immersed in a 0.5-percent solution of glucose in 0.85-percent sodium chloride solution at 38°C. for two hours, before the glucose content of the lens was determined. The glucose content ascertained minus the glucose content of a lens just removed plus the glucose metabolized by a rabbit lens at 38°C. was assumed to equal the amount of glucose which passed through the lens capsule in the two hours. The other intact lenses were dialyzed against physiologic salt solution for two hours at 38°C.; the glucose content of the originally sugar-free salt solution was used as a measure of the permeability of the lens capsule. The left eyes of the rabbits were not punctured and their lenses served as control material. For determination of the glucose content the Weekers modification of Dumazert's technic was used. In four tables, 16 experiments are described; the calculations resulted in evidence of a decrease of permeability of the lens capsule after repeated paracentesis. (References.) K. W. Ascher.

Duke-Elder, S., Davson, H., and Woodin, A. M. **Studies on the intraocular fluids.** Brit. J. Ophth. **33**:452-454, July, 1949.

This is the third of a series of studies

of the rate of penetration of various substances from the blood into the intraocular fluids. Creatinine, urea, glycine and alanine pass from the blood into the aqueous slowly and with difficulty and they enter the vitreous more slowly still. Urea, with a molecular weight of 60, penetrates at half the rate of glucose with a weight of 180. Its penetration can not be by simple transfusion but rather by transference through cell bodies.

Morris Kaplan.

Fanta, H. **The action of Priscol upon the normal and the diseased eye.** Arch. f. Ophth. **149**:199-219, 1949.

The author recommends Priscol (Ciba) where the production of a hyperemia, especially of the nervous tissues of the eye, is desired. Ernst Schmerl.

Hahn, G. **Iris stain in vivo.** Szemészet **1**:31-33, 1949.

To determine whether dyes are or are not stored in the living iris the author injected 8 to 10 ml. of a 1 to 10 dilution of india ink into the ear vein of albino rabbits. To learn whether or not the reticuloendothelium of eyes can be activated by histamin, 0.5 mg. of histamin was injected into one eye of a series of animals while the other eye served as control. The administration of histamin resulted in hyperemia and contraction of the pupils. The injection of ink in these animals was followed by grayish discoloration of iris and conjunctiva. The granules of ink could be detected in the histologic specimens of the iris while the control eye remained intact from all aspects.

Gyula Lugossy.

Latte, B. **Experimental investigation of the action of penicillin, streptomycin, and a combination of both, with sulfonamids, on vaccinial and herpetic eye lesions.** Boll. d'ocul. **28**:216-222, April, 1949.

The corneas of 25 rabbits, about one kilogram in weight, were infected with vaccinia, and 25 with herpes febrilis virus. Treatment consisted of instillation of penicillin ointment containing 1,000 Oxford units per gram, and of streptomycin solution, containing 1,000 gamma per milliliter. Both preparations were used at three hour intervals. Additionally diazil, 40 centigrams per kilogram of body weight, was administered intramuscularly twice a day to some of the animals. The ineffectiveness of the treatment is shown in ten tables, of which each describes a group of five animals. Similar observations on patients proved the usefulness of both penicillin and streptomycin in vaccinia and herpetic eye diseases. (Bibliography.) K. W. Ascher.

Leinfelder, P. J. **Aerobic glycolysis of corneal tissue.** Tr. Am. Ophth. Soc. **46**: 412-422, 1948.

Aerobic glycolysis of the corneal tissue of the rabbit occurs in the presence of added substrate. The maximum rate occurs when the concentration is above 0.6 mg. per cc. The epithelium accounts for two thirds of the value for whole corneas. Corneal tissue survives without an exogenous supply of glucose.

David O. Harrington.

Magitot, A. **The nerve routes connecting the retina to the hypothalmus.** Ann. d'ocul. **182**:569-585, Aug., 1949.

The optic nerve contains both centripetal and centrifugal fibers. At least two reflexes are involved in the arc which consists of the following structures: centripetal fibers from the retina, the hypothalmus, the cortex, and centrifugal fibers to the retina. The optopigmentary reflex affects melanophore pigment distribution throughout the body. In the eye it involves retinal pigmentation, and, in the skin, is affected in viteligo and canites.

The second reflex is the optosexual, which involves gonadal activity and which has been studied especially in birds. Retinal fibers pass directly to the tangential and ovoid nuclei in the hypothalmus. Centripetal optic nerve fibers enter the thalamus, the geniculate bodies, and the anterior quadrigeminal bodies. The thalamic fibers apparently arise by bifurcation of the geniculate fibers. One of the functions of the hypothalmus is the regulation of sensory impressions in terms of vasomotor and other autonomic impulses. The vascular control of the quantity and quality of the intraocular fluid as well as the size of the intraocular vessels is apparently closely associated with thalamic function. Almost all of the drugs usually used in glaucoma increase parasympathetic function directly or indirectly. This suggests that glaucoma is partially a vascular disease with insufficient vascular parasympathetic function throughout the body. The centrifugal fibers also partly regulate the chemical substances involved in light adaptation, and are apparently affected in some amblyopias and in visual hallucinations. Chas. A. Bahn.

Meyer-Schwickerath, G. **The electric resistance (impedance) of ocular tissues to high frequency currents.** Arch. f. Ophth. **149**:288-292, 1949.

The author measured and records the impedances of various eye tissues.

Ernst Schmerl.

Simonelli, Mario. **The permeability of the blood-aqueous barrier.** Giorn. ital. oftal. **1**:317-330, July-Aug., 1948.

After a brief review of recent related data the author reports his findings on man, when using the method of Amsler and Huber. Nicotinic acid, in doses of 6 ctg. produces an increased permeability of the blood-aqueous barrier in the majority of normal or pathologic eyes because it is a vasodilator. The permeability of the blood-aqueous barrier was also studied in 30 subjects before and after the administration of large doses of ascorbic acid, after the method of Amsler and Huber. The intravenous administration of Vitamin C (in doses of 50 to 100 ctg.) caused a notable increase in the permeability of the blood-aqueous barrier in healthy and in pathologic eyes. The administration of equal doses intramuscularly produced only slight and inconsistent changes of ciliary permeability. In no case was a decrease of the permeability of the blood-aqueous barrier observed.

Vito La Rocca.

Simonelli, Mario. **The permeability of the blood-aqueous barrier.** Giorn. ital. oftal. **1**:432-449, Sept.-Oct., 1948.

The permeability of the blood-aqueous barrier in patients with retinal detachment was studied according to the method of Amsler and Huber at various intervals after operation. In the majority of cases there was an imbalance between the ciliary permeability of the two eyes, with a noticeable increase in the afflicted eye. After recovery this imbalance disappears or, more rarely, becomes reversed so that the permeability is less in the operated eye. If there is no postoperative recovery the imbalance remains with greater permeability in the operated eye. The increase of permeability is generally closely related to the fact of greater or less adherence of the retina to the pigment epithelium.

The author also reports the effect of administering certain elements of the vitamin B complex on the permeability of the blood-aqueous barrier. Although injections of vitamin B_1 and B_6 in man do not effect in anyway the ciliary permeability of normal and pathologic eyes they do check the increase of permeability which usually follows the subcutaneous

injection of histomine. Vitamin B_2 (nicotinic acid) causes only a slight increase in ciliary permeability. Vito La Rocca.

Swan, K. C. **Ocular effects of the choline esters.** Tr. Am. Ophth. Soc. **46**:651-672, 1948.

A decade of experience in the ocular effects of the choline derivatives is reviewed. It is not possible as yet to evaluate the influence of these drugs on the intraocular vascular system but their effects on the muscles of the iris and ciliary body and upon intraocular pressure seem fairly well established. The question of corneal penetration and pharmacologic action of the choline esters is discussed with particular reference to their effect on intraocular pressure. The mydriatic cycloplegic action of Dibutoline and its range of clinical usefulness are discussed. David O. Harrington.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Berens, Conrad. **The contact lens problem.** J.A.M.A. **140**:602, June 18, 1949.

Considerable progress in the manufacturing and fitting of contact lenses has taken place in recent years. Nevertheless most patients can tolerate wearing the lenses for a limited time only because the solution used between the contact lens and cornea is unsatisfactory.

The American Committee on Optics and Visual Physiology recommends that the prescribing and fitting of contact lenses be restricted to properly licensed persons, that ophthalmologists establish a standard for approving the fitness of technicians, and that impartial research be initiated toward the solution of unsolved problems. R. Grunfeld.

van Beuningen, E. G. A. **Experimental observations concerning the sensitization of eye and ear during measurements of adaptation phenomena.** Arch. f. Ophth. **149**:230-239, 1949.

When the dark adaptation of several test persons was interrupted by short light stimuli, the readaptation increased in speed and intensity. Corresponding effects were observed in experiments in which the adaptation of the ear was studied. The author assumes that during the increased sensitiveness of the eye retinoneural functions prevail over photochemical processes. Ernst Schmerl.

Cibis, P., and Huck, H. **Studies of the central color sense in normal and congenital colorblind people using stimuli of definite size and duration.** Arch. f. Ophth. **149**:176-198, 1949.

The distances were determined at which the colors of small test objects on a neutral gray background were just recognized. The time was measured during which the perception of these stimuli faded. Large numbers of normal persons recognized the color of 1 by 16 mm. red and yellow objects and 1.4 by 16 mm. green and blue objects at distances of 3 m. or more. Where shorter distances were needed the color sense was doubtful or definitely pathologic. Normal persons also perceived the yellow color of test objects 5 by 5 mm. in size for a period of 2 minutes and at distances of 2 m. or more, whereas in pathologic cases the color was perceived at 1.2 m. distances or less. Ernst Schmerl.

Cross, A. G. **Contact lenses.** Brit. J. Ophth. **33**:421-445, July, 1949.

An analysis of the answers to a long, inclusive questionnaire sent to 1,850 patients who sent in 875 replies is presented. The results are most significant to all interested in the fitting and the problems of contact lenses. The most important aspect of the problem is the question of

tolerance to wear. Of those who replied to the questionnaire, one third have given up the wearing of their lenses which fact, in the light of the expense and time involved, emphasizes the great responsibility upon the fitter. The number of failures is considerably less among patients with a pathologic condition. Satisfactory fitting is still the major problem, and tolerance will increase with improvements in method. Morris Kaplan.

Durham, D. G. **Plastic lenses in industry.** Tr. Am. Acad. Ophth. pp. 680-682, July-Aug., 1949.

The advantages of plastic lenses in industry include greater resistance to pitting from sparks of different sorts, more resistance to fogging, lightness, and greater protection. (3 figures.)

Chas. A. Bahn.

Irvine, S. R. **Amblyopia ex anopsia. Observations on retinal inhibitions, scotoma, projection, light difference discrimination and visual acuity.** Tr. Am. Ophth. Soc. **46**:527-575, 1948.

This exhaustive monograph on the subject of amblyopia ex anopsia should be read in its entirety. Patients with nonparalytic strabismus fail to note apparent displacement of a fixated light during the cover test because the percipient elements of the retina that are involved because of the angle of squint have the same directional value as the macula of the fixing eye. This observation suggests that if, while one eye is fixating, prisms of varying strengths are moved before the deviating eye to displace the image less than the angle of squint, the image would not be seen or would be falsely projected. Moving prisms before an eye might be used to study projection, inhibition and scotoma in strabismus and amblyopia. Amblyopia based on organic lesions might be differentiated from amblyopia ex anopsia if retinal inhibition and projection were more altered in amblyopia ex anopsia. The prism displacement test proved valuable in the study of retinal inhibition and projection in strabismus and amblyopia. Numerous cases were analysed singly and in groups and an attempt was made to ascertain criteria helpful in prognosticating return of vision in the amblyopic eye of an adult after loss of the other eye.

David O. Harrington

Ludvigh, E. J. **Visual acuity while one is viewing a moving object.** Arch. Ophth. **42**:14-22, July, 1949.

Foveal visual acuity while one is viewing a moving object has received curiously little attention. The only reference to this subject is a note by Langmuir, who, in an effort to estimate the speed of a deer botfly, whirled above his head a piece of solder fastened to a string and noted at what speed the piece of solder appeared blurred. In view of the absence of any information, this subject was investigated.

Visual acuity was determined while the test object viewed appeared to move circularly in a plane perpendicular to the line of sight. The diameter of the circle and the velocity of the test object were varied. It is shown that when the eye is following such a moving object, acuity is reduced by reason either of the inability of the eye to move sufficiently rapidly or of the inability of the subject to adjust the relative innervation to the various ocular muscles sufficiently rapidly, or of both. It is shown that in following a moving object the extrafoveal position of the image is a negligible factor in producing the observed reduction of acuity. It is probable that imperfect pursuit movements, although maintaining the image in the immediate vicinity of the fovea, nevertheless result in a motion of the image on the retina which reduces visual acuity because the retina has less inten-

sity contrast. The hypothesis is confirmed by showing that increased illumination of the moving test object increases visual acuity. Ralph W. Danielson.

McDonald, P. R. **Evaluation of night vision.** Tr. Am. Ophth. Soc. **46**:576-607, 1948.

In the experiments reported the tenfold variation in the final rod threshold of healthy young adults confirms the findings of other investigators. Two different night vision tests employed have shown good reproducibility. It has also been shown that the visual threshold in normal persons is not improved with large doses of vitamin A. Given a good instrument and an interested examiner, a test of night vision becomes an important diagnostic aid as well as a means of demonstrating the important aspects of scotopic vision. David O. Harrington.

Pacalin, G. **Physiologic diplopia in depth perception.** Ann. d'ocul. **182**:617-635, Aug., 1949.

Depth perception fundamentally involves the mobility of accommodation and convergence as well as the coordination of binocular muscle balance, visual acuity and memory. Slight physiologic diplopia favors the perception of depth. Objects viewed at a closer distance than the fixation point cause crossed diplopia, and objects viewed at a greater distance than the fixation point cause homonymous diplopia. Two groups of figures are presented to illustrate that slight variations of accommodation and convergence change the apparent relative distances of objects from each other. These figures consist essentially of two larger circles with smaller eccentric circles arranged at less than the interpupillary distance. The cube of Necker is also employed to illustrate that the impression of a third dimension on the printed page is an optical illusion. The impression is produced through perspective and memory interpretation. The author believes that these fundamentals are important in the phorias and tropias. In the former, the process is reversible. Chas. A. Bahn.

Sauter, H. **A modification of telescopic spectacles by the use of contact glasses.** Arch. f. Ophth. **149**:142-155, 1949.

Contact lenses serve as oculars of these optical systems. The author considers magnification, size of the visual field and brightness of the image. Reference is made to a similar study by Bettman and McNair (Am. J. Ophth. 22:27, 1939). Ernst Schmerl.

Thomson, L. C. **Photopic luminosity curve and visual purple.** Brit. J. Ophth. **33**:505-508, Aug., 1949.

The author reports his investigation of the photopic luminosity curve. The contribution of the color-perceiving mechanism to the sensitivity of the light-adapted eye is represented. Maximum sensitivity is found in the spectral regions in which modulator activity is most marked. An attempt can be made to separate the activity of the brightness mechanism from that of the color-perceiving mechanisms in the human eye. Orwyn H. Ellis.

5
DIAGNOSIS AND THERAPY

Dansey-Browning, C. **On the use of amniotic membrane.** Brit. J. Ophth. **33**:518-520, Aug., 1949.

Amniotic membrane was used to replace a defect left by the excision of a large benign melanoma of the conjunctiva. The eye healed rapidly and almost without reaction. Orwyn H. Ellis.

Eröss, S. **Therapy of scleritis.** Szemészet **2**:74-76, 1949.

The etiology of scleritis is not uniform.

However, signs of oversensitivity can be found in all patterns. Therefore, the capacity of the organism to react should be transformed lest the process prove resistant to causal therapy. To this end, the author applied a specific stimulant therapy. Changes in the blood count and the sedimentation rate showed that paragen produced an adequate transformation of reactive capacity. Gyula Lugossy.

Guyton, J. S. **Enucleation and allied procedures. A review and description of a new operation.** Tr. Am. Ophth. Soc. **46**: 472-527, 1948.

The history and technic of extirpation, enucleation and evisceration of the eyeball with or without implants is thoroughly reviewed. Ruedemann's introduction of semiburied plastic eye implants and Cutler's use of a separate attachable prosthetic section initiated technics which usually result in normal appearance and motility of artificial eyes. Infection, extrusion, or reduced motility with the semiburied implants may be potential late complications. A procedure involving the use of an exoplant with which there is no contact of inert material with any tissue except epithelium introduces a new principle which may reduce late complications. David O. Harrington.

Harms, H. **Fundamentals, methods and meaning of pupillary perimetry for the physiology and pathology of the visual organ.** Arch. f. Ophth. **149**:1-68, 1949.

A complete study of the functions of a retinal area requires the determination of its light sense, its visual acuity, its color sense and its pupillomotor excitability. The present study compares perimetrically and under definite conditions light sense and pupillomotor excitability of the various retinal areas. A special instrument and threshold stimuli are used. The blind spot can be demonstrated by pupillary perimetry. Marked differences of pupillomotor excitability in normal persons are noticed. With dark adaptation the light sense shows a central scotoma while the pupillomotor excitability of the central fovea is at its maximum. Homonymous defects of the visual fields are paralleled by pupillomotor disturbances. Changes of the pupillomotor excitability are also found with foci proximally to the lateral geniculate bodies.

Ernst Schmerl.

Koch, H. **Contribution to the treatment of psychogenic amauroses.** Arch. f. Ophth. **149**:282-287, 1949.

In 9 cases of psychogenic amaurosis, electro-shock treatment or nitrous oxide narcosis was followed by definite improvement, Ernst Schmerl.

MacLean, A. L. **Surgical procedures in retinal vascular disease.** Tr. Am. Ophth. Soc. **46**:348-366, 1948.

Perforating scleral diathery with aspiration of the subretinal fluid is a safe and effective procedure in the treatment of serous retinal detachment complicating diabetic retinopathy. A glass applicator with broad concave tip is used and controlled negative pressure is supplied by an electric suction pump. The procedure is safe if the scleral opening is not too large or if the retinal opening has been sealed off by previous diathermy treatment. Cervical sympathectomy was used effectively in the treatment in one case of bilateral occlusion of the central retinal artery. David O. Harrington.

Schuessler, W. W., and Steffanoff, D. N. **Dermal grafts for correction of facial defects. (A series of 80 cases.)** Plastic and Reconstr. Surg. **4**:341-351, July, 1949.

Dermal grafts, free of subcutaneous fat, are used in various areas of the body for "fill-in material." Absorption of the der-

mal grafts show a decrease from the original volume of approximately 15 percent. A short history of the use of dermal grafts is given. This material should be used wherever there is a deficiency in the contour of the face, nose or forehead with normal skin to overlie it and a good vascular bed beneath it. It should not be used where firm structure is required, such as for protection of the brain tissue. It has the advantage over the cartilaginous graft of being soft and pliable, abundant and easy to remove and insert in the recipient area, and it seems much better than free fat-fascia graft. Various methods of obtaining dermal grafts are mentioned, and the author recommends the split-split method, introduced by Zintel. A full-thickness graft is removed with the dermatome, the dermatome reset and the desired thickness of epidermis recut on the dermatome. Sometimes the derma is inserted as a strip, or it may be cut in sections and packed up in the form of a pyramid. In 80 cases complications were present in 7.5 percent, of these 1.2 percent were due to infection, and 1.25 percent to cyst formation. Nine photographs and one drawing show this material used for repair of the atrophy of the retrotarsal fold after enucleation, for the adherent scars which form after severe trauma to the infraorbital rim, and for other regions of the face and nose.

Alston Callahan.

6
OCULAR MOTILITY

McLean, J. M. **Direct surgery of paretic oblique muscles.** Arch. Ophth. **42**:50-65, July, 1949.

The author discusses seven years' experience with direct surgery of the underacting superior oblique muscle and of the weak inferior oblique muscle. There appears to be no way by which to judge the amount of surgical correction required better than that of adjusting the tension according to the surgeon's sense of touch. The reasons for direct operative procedures to strengthen a weak oblique muscle are cited. Technics for tucking a paretic superior oblique and advancing a paretic inferior oblique muscle are described. Illustrative cases are reported. The methods of judging the amount of operation to be performed are discussed.

Ralph W. Danielson.

Murray, W. B. **A review of trachoma.** Canad. M.A.J. **60**:574-580, June, 1949.

The author gives a comprehensive review of the history, etiology, differential diagnosis, pathology and treatment of trachoma and stresses the fact that early diagnosis is important for the prevention of the spread of this mildly contagious disease. The modern treatment of trachoma is efficient. The incidence of trachoma among the Indians has been reduced from 26 to 3 percent within four years after the introduction of the new treatment by the U.S. Indian Service

R. Grunfeld.

Rubino, A., and Bassi, I. **Concomitant squint and status dysraphicus.** Giorn. ital. oftal. **1**:404-417, Sept.-Oct., 1948.

In a large number of patients with strabismus, the authors found a facial asymmetry very frequently. In the belief that facial asymmetry is a sign of status dysraphicus, they looked for other signs of this anomaly and found them in a large number of cases.

Vito La Rocca.

Scobee, G. **Intermittent exotropia.** Tr. Am. Acad. Ophth. pp. 658-673, July-Aug., 1949.

Anatomic abnormalities are the major factor in its causation. Complete cure is

usually possible surgically. Variations depend on mechanical obstacles to convergence, voluntary and involuntary convergence, and the strength of the fusion mechanism. Abnormalities of the intermuscular membranes, check ligaments, foot plate and other anomalies of insertion are the principal anatomic conditions involved. Exotropia is frequently greater at 20 feet than at 13 inches, unless occlusion or voluntary convergence relaxation is employed. The convergence near point is often practically normal. Generally speaking, intermittent exotropia or exophoria of 18 degrees or more can be cured only surgically. The author advocates bilateral external rectus recession performed at one time. Phorias require as much surgical correction as tropias. In the treatment of nonsurgical cases the pin-to-nose convergence exercise may decide the justification of further orthoptic training. Twenty-five cases, in 11 of which there were vertical deviations, are reported and analyzed. Chas. A. Bahn.

Stanworth, A. **The final results of squint operations in which restoration of binocular single vision was not expected.** Brit. J. Ophth. **33**:477-484, Aug., 1949.

The author presents a detailed study of the final binocular coordination in a group of patients in whom binocular single vision was not expected. In all it was concluded before surgery that orthoptic training would be unsuccessful, or it was tried and abandoned. The results showed that of the 26 percent that improved, 20 percent developed stereoscopic vision. Of the patients without binocular vision, 9 percent improved and of these 7 percent developed stereoscopic vision. Of those with simultaneous macular perception, 17 percent improved and 13 percent developed stereoscopic vision. The data suggest that if fusion will result it will do so within 12 months after operation. Patients with vision approximately equal in the two eyes tend to develop stereoscopic vision more readily than those with unequal vision. The size of the angle of deviation before operation appeared to be of little significance. An early onset of the squint usually precludes the attainment of good binocular vision. The alternating type has less chance of improvement than the unilateral type. There was apparently no optimum relationship of age to the time of operation. The postoperative angle of squint was most important. Of the patients with simultaneous perception and a deviation of five degrees or less after operation, 49 percent developed fusion, whereas only 11 percent of those with more than five degrees of deviation developed fusion. When there was no binocular vision but the deviation was less than five degrees, 22 percent of the patients developed stereoscopic vision and when the deviation was greater, only 4 percent developed fusion. Orwyn H. Ellis.

Wright, E. S. **Extraocular muscle paralysis from spinal injection of pantopaque.** California Med. **71**:214-215, Sept., 1949.

A case report of external rectus muscle paralysis which developed five days after the spinal injection of pantopaque is presented. Three months later spontaneous recovery occurred with normal motility.
Orwyn H. Ellis.

7

CONJUNCTIVA, CORNEA, SCLERA

Bietti, G. **Antibiotic therapy of virus diseases of the eye.** Ophthalmologica **118**:101-114, Aug., 1949.

Bietti and his associates have found penicillin, streptomycin and tyrothricin to be ineffective in keratitis due to herpes simplex and in epidemic keratoconjuncti-

vitis. In trachoma, however, the author reports definite, favorable response to frequent local applications of penicillin in concentrated aqueous solutions or ointments. Within a few days the secondary bacterial invaders as well as the inclusion and initial bodies disappear and the clinical picture improves correspondingly. The deeper tissue changes due to trachoma respond better to sulfonamides than to penicillin. Streptomycin and tyrothricin are ineffective in trachoma. The author considers the inclusion and initial bodies as the visible, corpuscular form of the virus. In contradistinction to its definite effect upon the trachoma virus penicillin does not alter the course of inclusion conjunctivitis. In one case of the latter disease the author observed rapid recovery under local streptomycin treatment. An extensive review of the literature is included. Peter C. Kronfeld.

Boase, A. J. **Eyelash in the lacrimal punctum.** Brit. J. Ophth. **33**:513, Aug., 1949.

A patient presented himself for treatment of an irritated right eye in 1944, and again for treatment of an irritated left eye in 1949. Each time there was an eyelash in the punctum and the root end protruded. Ulcer and granulation developed in the conjuntiva whereas keratinization is the expected change. Perhaps the rough root of the lash is more dangerous.

Orwyn H. Ellis.

Buecklers, M. **A new familiar type of corneal dystrophy.** Klin. Monatsbl. f. Augenh. **114**:386-397, 1949.

A complicated type of corneal dystrophy is described. The first signs appear during the childhood. There are severe defects of the epithelium with attacks of pain and inflammatory symptoms. The attacks stop after puberty and begin anew two decades later. At times there are corneal opacities without pain. The dystrophy involves the epithelium and, especially, Bowman's membrane. The mode of inheritance seems to be dominant. (1 family tree, 10 figures, references.)

Max Hirschfelder.

Cass, E. E. **Interstitial keratitis occuring in a case of Reiter's disease.** Brit. J. Ophth. **33**:454-455, July, 1949.

A case of Reiter's disease in a young man who also had severe interstitial keratitis combined with keratitis profunda and iritis in both eyes is reported. The disease progressed in severity despite all treatment and vision was reduced to the counting of fingers Morris Kaplan.

Cima, V. **Explanation of unusual reactions after transplantation of cadaver conjunctiva.** Boll. d'ocul. **28**:155-160, March, 1949.

Conjunctiva from the cadaver was first used for transplantation by Rosenzweig in 1939. In the Sassari and Pavia Eye Clinics, Bietti used this method repeatedly, preserving the cadaver conjunctiva for as short a time as possible in Ringer's solution with 5,000 units of penicillin per cc. The results were satisfactory but not better than autotransplantation of mucous membrane. In two cases of severe recurrent pterygium, however, marked reactions were observed and ascribed to tissue immunity reactions. (References.)

K. W. Ascher.

Cogan, D. G. **Nonsyphilitic interstitial keratitis with vestibuloauditory symptoms.** Arch. Ophth. **42**:42-49, July, 1949.

Four additional cases of the previously-described syndrome of nonsyphilitic interstitial keratitis with vestibuloauditory symptoms are reported. The interstitial keratitis was bilateral in three of the new

cases and unilateral in one. It was characterized by patchy, granular infiltrates in the deep stroma, which varied from day to day, unaccompanied by any conspicuous intraocular reaction. The vestibuloauditory symptoms were similar to those occurring in Ménière's disease and were followed by pratically complete deafness in three of the patients. The ocular and vestibuloauditory symptoms appeared within a few days in three patients but were separated by a five month interval in one. Again all four patients were young adults, all had a leukocytosis, and one a significant eosinophilia.

Ralph W. Danielson.

Coppez, L. **Partial lamellar keratoplasty.** Ann. d'ocul. **182**:597-604, Aug., 1949.

This type of operation should be more extensively used because it affords better vision in eyes not adapted to total keratoplasty. Among its advantages are more rapid recovery and better nutrition of the graft, as well as its simple technique and the infrequency of surgical complications. The author reports nine cases in detail with illustrations which show the regularity of the reflecting surface of the cornea after operation. The Franceschetti technique is used. Chas. A. Bahn.

Corrado, A., and Toselli, C. **Hereditary luetic parenchymatous keratitis.** Rassegna ital. d'ottal. **18**:97-111, March-April, 1949.

Eighty percent or more of luetic keratitis was found to be hereditary. Trauma was an unimportant cause in the development of the lesion. The authors studied 106 cases of the disease and have tabulated many data. Sixty-seven percent of the cases developed the keratitis under 20 years of age and 66 percent of all patients were females. The serologic tests were positive in all but four cases. Complications, such as posterior synechiae, dense corneal opacities and irregular astigmatism were more frequent when the disease appeared first in later life.

Eugene M. Blake.

Das Gupta, B. K., and Usman, M. **Bilateral symmetrical tuberculous ulcers of the bulbar conjunctiva treated with streptomycin.** Brit. J. Ophth. **33**:501-505, Aug., 1949.

Bilateral tuberculous ulcer of the bulbar conjunctiva did not respond to ordinary therapy but healed promptly when streptomycin drops of high concentration were used. Acid-fast bacilli were found in the scrapings. (4 figures in color.) Orwyn H. Ellis.

ten Doesschate, J., and Fischer, F. P. **Some statistical observations on the frequency of occurrence of pterygium and pinguecula in relation to age.** Ophthalmologica **118**:137-142, Aug., 1949.

The incidence of pinguecula as a function of age is expressed by an S-shaped curve which rises very slowly up to the age of 15 years. There the curve makes a sharp bend and starts to rise steeply up to the age of 50 years, where it begins to taper off. Plotted on log-log paper the incidence of pinguecula becomes a linear function of the subject's age. The incidence of pterygium follows a similar pattern but all frequencies are considerably lower than those of pinguecula. The hypothesis is offered that the persons liable to develop pterygium form a distinct group of the population. In this group also, the relationship of the incidence of the disease to age is expressed by a similar S-shaped curve.

Peter C. Kronfeld.

Drescher, E. P., and Henderson, J. W.

Senile hyaline scleral plaques. Proc. Stf. Mtgs. Mayo Clin. **24**:334-336, June 8, 1949.

Three cases of senile hyaline plaques are reported from the Mayo Clinic to clarify the diagnosis of this condition. The usual location, the clinical appearance, and the pathology are described.

Donald T. Hughson.

McGavie, J. S. **Surgical treatment of recurrent pterygia.** Tr. Am. Ophth. Soc. **46**:608-632, 1948.

An operative technic is described for the eradication of severe recurrent pterigium. The results were good in a series of 38 cases in which other procedures had failed to prevent recurrences. The procedure consists of lamellar peratectomy, submucous resection of all scar tissue, recession of the conjunctiva by suturing it to the sclera proper at least 5 mm. from the corneoscleral junction and allowing the denuded cornea and sclera to become epithelized. Beta radiation is used postoperatively when necessary to control vascularization. The technique is also suitable for pseudopterigia, epibulbar tumors, repair of symblepharon and removal of superficially vascularized scars. The literature is reviewed. (References.)

David Harrington.

Rosen, E. **The importance of the cornea in virus diseases.** Ophthalmologica **118**: 81-101, Aug., 1949.

The pathogenesis of corneal lesions in systemic virus infections is discussed in the light of the newer concepts concerning the antigen-antibody relationships in such diseases. Typical clinical cases are reported to illustrate the author's views. The difference in response between the avascular center and highly vascular periphery of the cornea is stressed.

Peter C. Kronfeld.

Rubino, A., and Simonelli, M. **Thymus radiation for the treatment of vernal catarrh.** Giorn. ital. oftal. **1**:453-455, Sept.-Oct., 1948.

The thymus was irradiated with X rays in 15 patients, 8 to 20 years of age, with vernal catarrh, without any noticeable improvement. The findings are in contrast with those of Stanhope, who believed that the hypertrophy of the thymus was a fundamental element in pathogenesis of vernal catarrh.

Vito La Rocca.

Taussig, J. **Epithelioma of the cornea following a cement burn.** South African M. J. **23**:383-384, May 14, 1949.

A 35-year-old man injured his left eye with particles of cement. A slight burn of the bulbar conjunctiva and tarsus of the left eye ensued. Two years later a small tumor developed at the limbus and spread toward the pupil. The adjacent conjunctiva was injected in pterygium-like fashion and scattered through it were discrete, pinhead-sized, wart-like tumors. Two fragments of tissue were removed. One fragment consisted of simple pigmented squamous papilloma overlying a single mucous gland, the other showed squamous carcinoma.

R. Grunfeld.

Vannini, Angelo. **The treatment of conjunctivitis due to Morax-Axenfeld diplobacillus.** Rassegna ital. d'ottal. **18**:131-134, March-April, 1949.

In an attempt to determine whether any other medication was equal to or superior to zinc sulfate in the treatment of diplobacillary conjunctivitis Vannini administered sulfonamides, penicillin and streptomycin. While the average time of disappearance of the bacilli was 8 to 10 days with zinc, it was reduced to four days using 30-percent sulfacetamide drops every two hours. Penicillin and streptomycin were wholly ineffective.

Eugene M. Blake.

Venco, Luigi. **Disturbances at the limbus in keratoplasty.** Rassegna ital. d'ottal. **18**:65-80, March-April, 1949.

The term "diseases of the limbus," employed by several French ophthalmologists, includes all of the accidents, necroses and opacification which occur at times in well executed corneal transplants. These complications may be divided into precocious necrosis, or that which occurs in the first few days, opacification developing about the third week, and delayed scarring of the transplant. Venco believes that the fundamental factor which determines the changes is trophic and vital and that necrobiotic, anaphylactic and allergic agents are not importnat.

Eugene M. Blake.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Alvarez, A. A. **Late syphilitic uveitis healed by penicillin in massive subconjunctival injections.** Ann. d'ocul. **182**:521-524, July, 1949.

50,000 units of penicillin with 2-percent novacaine and 1 to 1,000 adrenalin was injected subconjunctivally every six hours during one day. 3,000,000 units were administered intramuscularly during eight days. Improvement promptly followed the treatment in a 42-year-old man with bilateral luetic uveitis which had responded badly to other antiluetic treatment during eight months. Vision improved from .05 to .5.

Chas. A. Bahn.

Blanchi, Guido. **Plastic uveitis in Schoenlein-Henoch disease.** Rassegna ital. d'ottal. **18**:114-120, March-April, 1949.

Cutaneous hemorrhages are divided into four groups by Blanchi. They are those associated with 1. avitaminosis (scurvey), 2. hemophilia, 3. essential thrombopenia (Werlhof's disease), and 4. purpora hemorrhagica of Schoenlein-Henoch. The latter presents a complex picture of an infection which may be acute or with recurrent attacks, and of unknown etiology. The commonest ocular complication is hemorrhage in the retina, under the conjunctiva and in the lids.

Three cases of uveitis are described, the first in a child of one year, resulting in atrophy of the globe. The disease, in the second patient, aged 12 years, ended with a shrunken globe, and in the third, aged 18 years, in a blind eye. All forms of treatment with the usual drugs and antibiotics were unavailing.

Eugene M. Blake.

Custodis, E., and Heineman, K. **Observations of retinal changes in tuberculous meningitis and in miliary tuberculosis.** Klin. Monatsbl. f. Augenh. **114**:356-363, 1949.

Sixty-two children with tuberculous meningitis or miliary tuberculosis of the lungs or a combination of the two diseases were observed up to 220 days. Tuberculous infiltrates in the choroid were considerably more frequent in miliary tuberculosis of the lungs, whether it was associated with tuberculous meningitis or not. They were less frequent in patients with tuberculous meningitis who showed no involvement of other organs but even of this latter group 41 percent showed involvement of the choroid, which is a relatively high figure. It is likely that the extended observation made possible by streptomycin brought out changes in the eyegrounds which formerly had not been observed because of the early death of the patient. The authors noted the appearance of fresh tubercles in the choroid in four patients who were under active streptomycin treatment. Most tubercles in the choroid were located near the posterior pole and only very rarely were they found in the equatorial region.

Max Hirshfelder.

François, J. **Contribution to the study of the heterochromia of Fuchs and its pupillary sign. (Sympathetic pathogenesis.)** Ann. d'ocul. **182**:585-596, Aug., 1949.

Earlier conceptions of Fuchs's heterochromia, like those of many other primary constitutional diseases require revision. The disease is not monocular, nor is the lighter eye always the first to show the degenerative changes. A study of the literature and an analysis of nine cases lead the author to believe that Fuchs's heterochromia iridis is essentially a constitutional, degenerative disease which involves especially the anterior uveal tract, and is frequently associated with degenerative changes in the superficial cervical ganglion. The discoloration of the iris is associated with abnormal pigmentation and pigment dispersion. Pigment becomes dispersed and the iris tissue absorbed because of the basic subnormality of the uveal tissue. The associated sympathetic subnormality makes eyes with this disease abnormally sensitive to parasympathetic stimulation, and insensitive to sympathetic stimulation, as is illustrated by the pupillary reactions. The effect of the following drugs, adrenalin, cocaine, acetyl-methyl-chloride, atropine and eserine, on the eyes of the nine patients, was studied. Chas. A. Bahn.

Garden, R. R., and Wear, A. R. **Iridoschisis in a case of chronic primary glaucoma.** Brit. J. Ophth. **33**:509-511, Aug., 1949.

A case of iridoschisis with chronic primary glaucoma is reported. It appears that the basic changes are senile but that the process may be aggravated by proteolytic enzymes in the aqueous and, in this case, the product of glaucomatous metabolism. The change was chiefly in the lower half of the iris and gravity or convection currents may play a part in its development. Orwyn H. Ellis.

Malatesta, C. **Rare case of conglomerate tuberculosis of the ciliary body.** Boll. d'ocul. **28**:223-234, April, 1949.

A 7-months-old boy developed skin eruptions of ulcerative type, swelling of numerous lymphatic nodules, and severe roentgenographic changes in his right lung. The right eyeball was atrophic and showed an almost complete destruction of the cornea and grayish-brown masses protruding from the defect. An eye specialist saw the child 3 months before the admission and found pericorneal injection, and opaque edematous cornea, fibrinous exudation in the shallow anterior chamber, and increased intraocular pressure. The eyeball was finally enucleated; the ciliary body had been replaced by tuberculous granulations. The mother had had an exudative pleuritis before the child was born. There is a discussion of the immunity factor in early life. (3 photomicrographs, references.)

K. W. Ascher.

9

GLAUCOMA AND OCULAR TENSION

Ascher, K. W. **Aqueous veins and their significance for pathogenesis of glaucoma.** Arch. Ophth. **42**:66-76, July, 1949.

After an excellent and authoritative discussion of aqueous veins, the author concludes that the elimination of intraocular fluid can be studied biomicroscopically. Considered as a unit of clinicopathologic importance, the canal of Schlemm and the aqueous veins show parallel changes in congestion and in inflammation; in primary simple glaucoma their responses are apparently contradictory so far as blood has a tendency to overwhelm the aqueous humor and to stream back against, but not into, the canal, which in eyes with normal pressure often becomes filled with blood during gonioscopic observation. These apparent contradictions can be explained in at least

some cases of glaucoma by the assumption of a narrowing of the canal outlets.

Ralph W. Danielson.

Cristini, Giuseppe. **Cardio-aortic and sinucarotid reflexes in primary glaucoma.** Giorn. ital. oftal. 1:385-403, Sept.-Oct., 1948.

The author discusses the relation between ocular tension and blood pressure and reports his studies of the cardio-aortic and sinucarotid reflexes in primary glaucoma. The stimulation of the vaso-sensitive areas causes different changes of ocular tension in relation to blood pressure according to whether the patient has high or normal ocular tension at the moment of examination. He analyzes these different reactions that occur in the two stages of glaucoma and calls attention to the consequences that an exaggerated reflex of the vasosensitive area can have on the appearance of an acute attack of glaucoma, and its course.

Vito La Rocca.

D'Ombrain, Arthur. **Traumatic or "concussion" chronic glaucoma.** Brit. J. Ophth. 33:495-500, Aug., 1949.

The observations on a series of cases of monocular chronic congestive glaucoma are presented. It is suggested that there exists a type of chronic glaucoma of traumatic origin. The trauma may produce a chronic process of gradual and progressive blockage of the trabeculum by a sclerotic degeneration or proliferative lesion. The time of onset varies from a few weeks to many years after injury.

Orwyn H. Ellis.

Galton, E. M. G. **A note on the effect of sleep on glaucoma.** Brit. J. Ophth. 33:-511-512, Aug., 1949.

Observations of the effect of sleep on glaucomatous eyes is presented. The rise in tension may be due to immobility of the lids and eyeballs with consequent lack of massage to the globe.

Orwyn H. Ellis.

Rubino, A. **Trephining and cyclodiathermy associated in the treatment of glaucoma.** Giorn. ital. oftal. 1:450-452, Sept.-Oct., 1948.

The author has associated Elliot's trephining with superficial cyclodiathermy in the treatment of 10 patients with glaucoma for whom the usual methods were not suitable, with favorable results in all. There is a lowering of the tension and a disappearance of inflammation during the year which has elapsed.

Vito La Rocca.

Sanna, M. **The reflexes of Brown-Sequard and of Tholozan in glaucomatous patients.** Boll. d'ocul. 28:193-206, April, 1949.

In order to examine the neurovegetative sympathetic medullary centers, Sanna applied thermic tests to 12 normal and 11 glaucomatous patients. While the right hand was immersed in water, the skin temperature of the left hand was registered at 5-minute intervals. To provoke vasodilatation, water at 42 to 45 degrees C. was used; for vasoconstriction, water at 10 degrees C. Skin temperatures were measured with the thermoelectric device "Thykos." A tendency to or a definite vasoconstrictive tonicity of the circulatory system was found in 8 of 11 glaucomatous patients while only 7 of the 12 now glaucomatous showed this tendency. In 10 of 11 glaucomatous patients a "lassitude of the vasoconstrictive sympathetic medullary centers" was found.

K. W. Ascher.

Stanworth, A. **The cornea in polarised light (preliminary communication).** Brit. J. Ophth. 33:485-490, Aug., 1949.

Corneal strips from cats' eyes were ex-

amined under polarised light. The birefringence of the corneal lamellæ rapidly increases with elongation of the strips. In a physiological range there should be a fairly rapid increase of birefringence with a rise in intraocular pressure. The results suggest that further studies may make the measurement of stress-birefringence available as an optical method for measuring changes in intraocular pressure. Orwyn H. Ellis.

Wolff, Eugene. **The subconjunctival ab externo approach in glaucoma.** Brit. J. Ophth. **33**:514-518, Aug., 1949.

The use of a subconjunctival ab externo incision in glaucoma facilitates the performance of filtering operations. The procedure is described in detail. The conjunctival flap is retracted by the assistant with a nontoothed forceps. The operator fixes the eye with a scleral hook and makes the incision into the anterior chamber with a sharp scalpel. The safety and relative ease of performance are stressed. Orwyn H. Ellis.

10
CRYSTALLINE LENS

Davids, B. **Genesis of the complicated cataract.** Arch. f. Ophth. **149**:156-175, 1949.

The cataracta complicata as well as the X-ray cataract are interpreted as sequelae of an injury to the lense epithelium which results in a necrobiosis of cells and fibers and the development of generations of pathologic cells. Other types of cataract also show epithelial changes. Quantum processes are considered as genetic factors of these pathologic processes.

Ernst Schmerl.

Gasteiger, H. **Cataract extraction in trephined eyes.** Klin. Monatsbl. f. Augenh. **114**:370-385, 1949.

The result of cataract extraction in 44 eyes which had had trephine surgery for glaucoma are reported. It is estimated that cataract follows 10 percent of all trephine surgery, but is not more frequent after trephining than after any other glaucoma operation. Eyes which require multiple glaucoma surgery more frequently develop lens opacities. The author favors intracapsular extraction. His section is usually a Graefe incision without conjunctival flap and avoids the filtering bleb. Cataract extraction did not influence the ocular tension and the visual field unfavorably, and normal intraocular pressure previously established by the trephine operation was usually maintained. (1 figure, references.)

Max Hirschfelder.

Harrington, D. O. **Mechanics of intracapsular cataract extraction.** Arch. Ophth. **42**:23-41, July, 1949.

In order to acquire the greatest proficiency in intracapsular cataract extraction the surgeon should have an understanding of the physical principles underlying the dislocation and delivery of the lens. It can be demonstrated by slit lamp microscopy and by gonioscopic observation during actual intracapsular cataract extraction in the eye of a living animal and a human cadaver that the rupture of the zonular lamella of the lens is accomplished primarily by the production by external pressure of a wedge of vitreous, which is made to insert itself between the equator of the lens and the ciliary processes. This deformity of the vitreous can be produced by choosing the method and the point of application of the external pressure at whatever site is desired so that one may tumble or slide the lens from its position in the hyaloid fossa. The normal vitreous is a tissue and cannot be considered as a fluid in which pressure at one point is transmitted equally to all other parts. Capsular trac-

tion facilitates dislocation of the lens by stretching the zonule, but does not normally produce its rupture.

Ralph W. Danielson.

Kuhn, H. A., and Kuhn, H. S. **Monocular cataracts: industrial implications.** Tr. Am. Acad. Ophth. pp. 682-686, July-Aug., 1949.

Should a monocular cataract in an industrial patient be extracted if vision in the other eye is normal? Eighty-two such lens extractions are analyzed to show that the risks, cost and discomforts of operation are justified in some cases. Among the potential advantages are better vision for positions requiring binocular vision, a favorable time for cataract extraction and relative infrequency of postoperative discomfort. Chas. A. Bahn.

11
RETINA AND VITREOUS

Campos, R. **Vitreous-body detachment and its relation to retinal detachment.** Boll. d'ocul. **28**:12-154, March, 1949.

Detachment of the vitreous body was first described anatomically by H. Müller in 1856 and ophthalmoscopically by L. Weiss 41 years later; in 1922 the first biomicroscopic description was made by Pillat. Campos summarizes previous classifications distinguishing prebasal and retrobasal detachments; the latter may begin in the upper or in the posterior part of the vitreous body. According to the distance between retina and hyaloid membrane the posterior detachment may be incomplete or complete. Lateral detachments are questionable. Etiologic factors are inflammation, senile changes and degeneration of the colloids constituting the vitreous-body framework. Subjective symptoms are scarce: phosphenes of short or longer duration occur. The first to assume a possible connection between traction of the vitreous body and retinal detachment was Iwanoff (1869). Leber and Nordenson described preretinal fibrous threads formed by proliferating cells; Gonin (1918) concluded, from the shape of most of the retinal holes, that vitreous traction on the retina was responsible for retinal detachment. This theory found numerous defenders but Vogt doubted the importance of traction and stressed peripheral and macular cystic degeneration of the retina as the main etiologic factor in detachment. Campos studied 60 eyes with retinal detachment, using Lindner's angular corneal microscope with arc light and the −55.0-diopter lens of Hruby. In 66 to 93 percent of eyes with retinal detachment, vitreous detachment was present. The highest precentage occurred in the aged and those with high myopia. The fellow eyes showed vitreous detachments in more than 60 percent of the eyes. (51 references.) K. W. Ascher.

Delaney, A. J., and Rhoades, A. L. **Angioid streaks of the retina: case report.** U.S. Naval Med. Bull. **49**:572-574, May-June, 1949.

Angioid streaks of the retina occurred in a patient who had pseudoxanthoma elasticum. Donald T. Hughson.

Gandolfi, C. **Pathogenesis of retinitis circinata.** Giorn. ital. oftal. **1**:425-431, Sept.-Oct., 1948.

A case of retinitis circinata with senile macular degeneration and numerous scattered spots at the periphery is reported. The author believes that retinitis circinata, like macular degeneration and scattered retinitis, is a manifestation of angiopathy of the retina. Vito La Rocca.

Herson, R. N., and Sampson, R. **Ocular manifestations of polyarteritis nodosa.** Quart. J. Med. **18**:123-132, April, 1949.

The authors report the ophthalmoscopic findings in four patients with polyarteritis

nodosa who later came to autopsy. The ophthalmoscopic signs began with blurring of the edges of the disc and with one or two small hemorrhages adjacent to it. Soon wide areas of retinal edema appeared and detachments of the retina of various sizes occurred with spontaneous recovery sometimes in less than three weeks. In three cases nodules of choroiditis were found which rapidly progressed to the formation of pigmented scars. In one case the retinal arteries were directly affected by the polyarteritic process. Arteritis, obstruction of lumen, aneurysmal dilatation, and scar formation could be observed in succession. The ocular findings have a grave prognostic significance. The average duration of life in all four cases was about six weeks after the discovery of the first eye signs. R. Grunfeld.

Jahnke, W. **Treatment of retinitis diabetica with insulin.** Arch. f. Ophth. **149**: 240-247, 1949.

Vasodilatation and increased capillary permeability are considered the dangers in the treatment with insulin. The author recommends that a blood sugar level of from 130 to 160 mg. percent be maintained. Ernst Schmerl.

McLean, M., and Solanes, M. **Anticoagulant therapy in retinal vascular occlusion.** Tr. Am. Acad. Ophth. pp. 644-657, July-Aug., 1949.

The pharmacology of heparin and dicumarol are briefly discussed. The former is administered only intravenously and preferably in 50 to 100-mg. doses at 4 to 6-hour intervals. The latter, which is slower in action, is preferably administered orally as capsules. The initial dose is 200 to 300 mg. and the maintenance dose is 50 to 200 mg. If complications ensue the drugs are discontinued and whole blood or vitamin K are administered intravenously. Forty-one patients treated with anticoagulants are reported. In venous occlusions a subendothelial and endothelial proliferation apparently occurs with the formation of a canalized thrombus. Anticoagulants apparently act by decreasing or slowing the accelerated rate of blood clotting and thus inhibit the formation of additional clots. Anticoagulant therapy should be started soon after the condition occurs and should be continued until the prognosis is determined. Although visual improvement occurred in a number of the cases treated with anticoagulant therapy, its specific indications have not yet been accurately determined. Chas. A. Bahn.

Rosengren, Bengt. **Pathogenesis of fundus changes in arterial hypertension.** Klin. Monatsbl. f. Augenh. **114**:328-333, 1949.

The vascular changes in the retina in benign hypertension are similar to those found in other organs, mainly those in the region of the splanchnic nerve. In malignant hypertension the process is exudative with edema and hemorrhages superimposed on very constricted arteries. Proliferation of the intima, hyaline degeneration of the media, fibrinoid degeneration of the adventitia are found. The author doubts that the retinal changes are a result of mere ischemia and points to cases of complete ischemia due to arterial occlusion which in no way resembled the picture of malignant hypertension. Renal insufficiency does not in itself explain the fundus changes. The possibility of a toxic substance as well as a purely mechanically damaging effect in hypertension must be considered.

Max Hirschfelder.

NEWS ITEMS

Edited by DONALD J. LYLE, M.D.
601 Union Trust Building, Cincinnati 2

News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received by the editor at least three months before the date of occurrence.

DEATHS

Dr. Lloyd Glenn Dack, St. Paul, Minnesota, died July 9, 1949, aged 59 years.

Dr. Clyde Elliott McDannald, New York, New York, died August 13, 1949, aged 73 years.

Dr. William Denton Rowland, Boston, Massachusetts, died July 1, 1949, aged 69 years.

ANNOUNCEMENTS

SCHOENBERG MEMORIAL LECTURE

The Mark J. Schoenberg Memorial Lecture will be held at the New York Academy of Medicine at 8:30 p.m., Monday, December 5th, under the joint sponsorship of the New York Society for Clinical Ophthalmology and the National Society for the Prevention of Blindness. Dr. Jonas S. Friedenwald, Baltimore, Maryland, will discuss "Some problems in the diagnosis and treatment of glaucoma."

This lectureship was established as a memorial to Dr. Schoenberg's interest and original work in the control of glaucoma.

On the committee in charge of arrangements for the meeting are Dr. Willis S. Knighton, chairman; Dr. Isadore Givner, Dr. James W. Smith, and Dr. Franklin M. Foote.

TEMPLE FACULTY PROMOTIONS

The following promotions have been made on the faculty of the Temple University School of Medicine: Dr. Robison D. Harley from associate to assistant professor of ophthalmology; Dr. William Hart from associate to assistant professor of ophthalmology; and Dr. Louis Hinman from instructor to associate of ophthalmology.

WILDER MEMORIAL LECTURE

The William Hamlin Wilder Memorial Lecture, "Medical ophthalmology: A Kodachrome demonstration of fundus photographs of diabetes, hypertension, nephritis, optic neuritis and choked disc," was delivered by Dr. Arthur J. Bedell, Albany, New York, at a joint meeting of the Institute of Medicine of Chicago and the Chicago Ophthalmological Society on October 14th in Chicago.

SOCIETIES

READING SOCIETY

The 96th meeting of the Reading Eye, Ear, Nose, and Throat Society and the sixth joint meeting with the Berks County Medical Society was held on September 13th. It was a symposium on diabetes. Dr. Milton P. Adel, New York City, discussed "What can the internist tell us?" and Dr. Irving H. Leopold, Philadelphia, "How does the ophthalmologist help?"

Officers of the Reading Society for the year 1949 to 1950 are: President, Dr. William J. Hertz, Allentown; 1st vice-president, Dr. John M. Wotring, Reading; 2nd vice-president and president-elect, Dr. Roy Deck, Lancaster; treasurer, Dr. Philip R. Wiest, Reading; secretary, Dr. Paul C. Craig, Reading; program chairman, Dr. C. Fremont Hall, Phoenixville.

PERSONALS

MADE HONORARY MEMBER

On Friday, October 21st, at the annual convocation of the American College of Surgeons, Sir Stewart Duke-Elder was installed as an honorary member of the organization in a colorful ceremony.

AWARDED LESLIE DANA MEDAL

Dr. Conrad Berens, New York, was awarded the Leslie Dana Medal for the Prevention of Blindness in recognition of his outstanding contributions to ophthalmology at a dinner in his honor at the Chase Hotel, Saint Louis, Missouri, on October 15th. The medal is presented by the Saint Louis Society for the Blind in coöperation with the National Society for the Prevention of Blindness and the Association for Research in Ophthalmology.

GIVES LECTURE IN CUBA

Capt. Arthur Alexander Knapp (MC) U.S.N.R., has recently returned from Havana, Cuba, where he conducted a course in "Plastic surgery of the eye," at the university and presented a paper on "Highlights of eye surgery," before the Cuban Ophthalmological Society.

LECTURES IN TENNESSEE

Dr. Arthur J. Bedell, Albany, New York, delivered a lecture entitled, "The ophthalmoscopic signs of constitutional disease," before the Nashville Academy of Medicine and Davidson County Medical Society on October 5th in Nashville, Tennessee.

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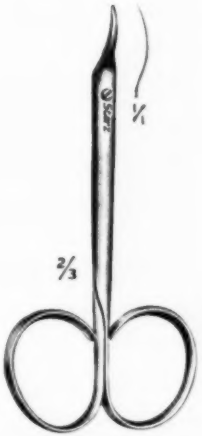

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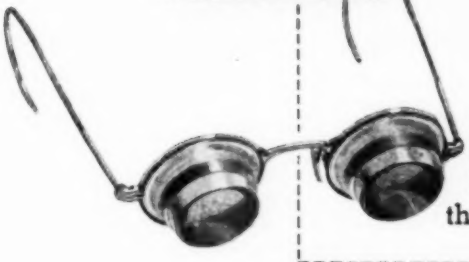

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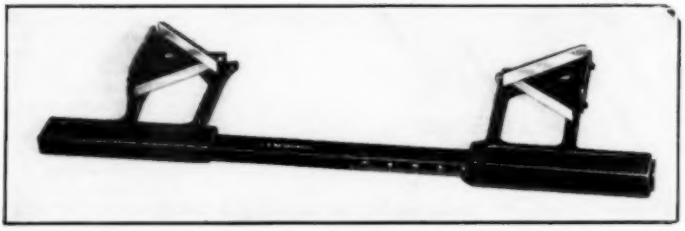

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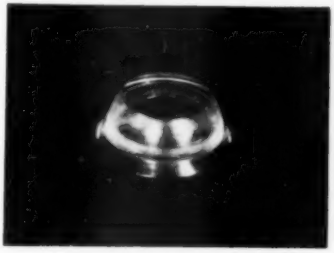

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